Metallic structure and bonding

This resource is from the **Johnstone's triangle** series which can be viewed at: rsc.li/3YE7pdl

Use this resource after completing our **Metallic bonding in copper: Johnstone's triangle** worksheet which can be viewed at: rsc.li/3LY2IDz

Learning objectives

LO	Objective	Where assessed
1	Use an appropriate model to explain the properties of a metal or alloy.	Q1 and 2
2	Explain why a positive ion is charged.	Q3
3	Use an atomic structure diagram to interpret a metallic bonding diagram.	Q4
4	Describe the nature of metallic bonding.	Q5
5	Evaluate a model of metallic bonding.	Q6

How to use the resource

Use these questions to develop your learners' mental models of the different structures of carbon. The icons in the margin indicate which level of understanding the question is developing. Ask learners to first complete the **Metallic bonding in copper: Johnstone's triangle** worksheet (available from rsc.li/3LY2IDz), then refer to it to support them in answering these questions.

Macroscopic: what we can see. Think about the properties that you can observe, measure and record.

Sub-microscopic: smaller than we can see. Think about what is happening at a particle or atomic level.

Symbolic: how we represent what is happening. Think about the models you use to represent what you cannot see including diagrams and symbols.

For questions with the 'macroscopic' icon in the margin it is useful for learners to observe these macroscopic properties first-hand. You can circulate examples of substances in the classroom or show a teacher demonstration of properties. For questions with the 'symbolic icon' in the margin it is useful for learners to have physical models to use and manipulate, such as a Molymod™ kit.

You can use this resource in a variety of ways. It works best as a follow up activity to an initial teaching or discussion of metallic structure. Use the worksheet straight away in the same lesson or as a homework. If completing as an in-class activity it is best to pause and check at intervals, as often one question builds on the previous one. You can also use this resource as a retrieval/revision activity later on to check that students do not have any misconceptions. Depending on the learners, the activity should take from 15 to 30 minutes. The resource works well as a worksheet for independent work but you can also use the questions for group or class discussions.

Scaffolding

The earlier questions are designed to be accessible to all learners. The activity becomes more challenging in the latter stages. You can choose to give extra explanations for the more challenging questions.

Answers

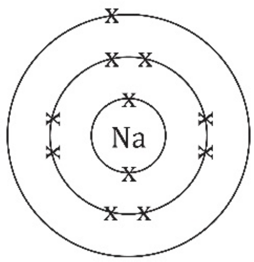
1. (a) Model A.

(b) Copper is ductile because the atoms can move across each other.
(c) Electrons
(d) The metallic structure model does not show any (delocalised) electrons.

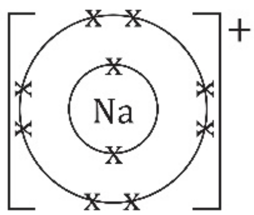
2. (a) Model B

(b) An alloy is strong because the atoms are different sizes. This distorts the structure and makes it more difficult for atoms to move past each other. This is shown most clearly by model B.
(c) A
(d) Model A shows delocalised electrons.

3. (a)



(b)

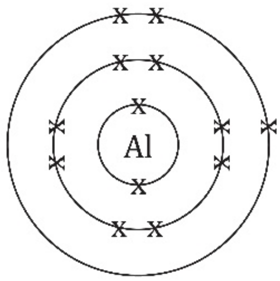


(c) +11
(d) The charge of a sodium nucleus is +11. A sodium ion has only 10 negatively charged electrons. The overall charge of a sodium ion is therefore 11-10 = +1.

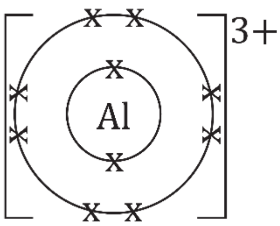
4. (a) outer electrons

(b) nucleus and inner electrons

5. (a)



(b) 13
(c) +3
(d)



(e) There will be three delocalised electrons because an aluminium atom has three outer electrons.
(f) Metallic bonding arises from the electrostatic attraction between the negative delocalised electrons and the remaining positively charged ion (made up of the nucleus and inner electrons).

6. (a) This model represents the delocalised electrons as a ‘sea of electrons’. This analogy gives the idea that the electrons are free to move which can help to explain why a metal can conduct electricity.

(b) One disadvantage of this model is that the negative charge of the delocalised electrons is not made clear.
Another disadvantage is that this model shows the metal ions being spaced out when for a solid metal they should be touching.