

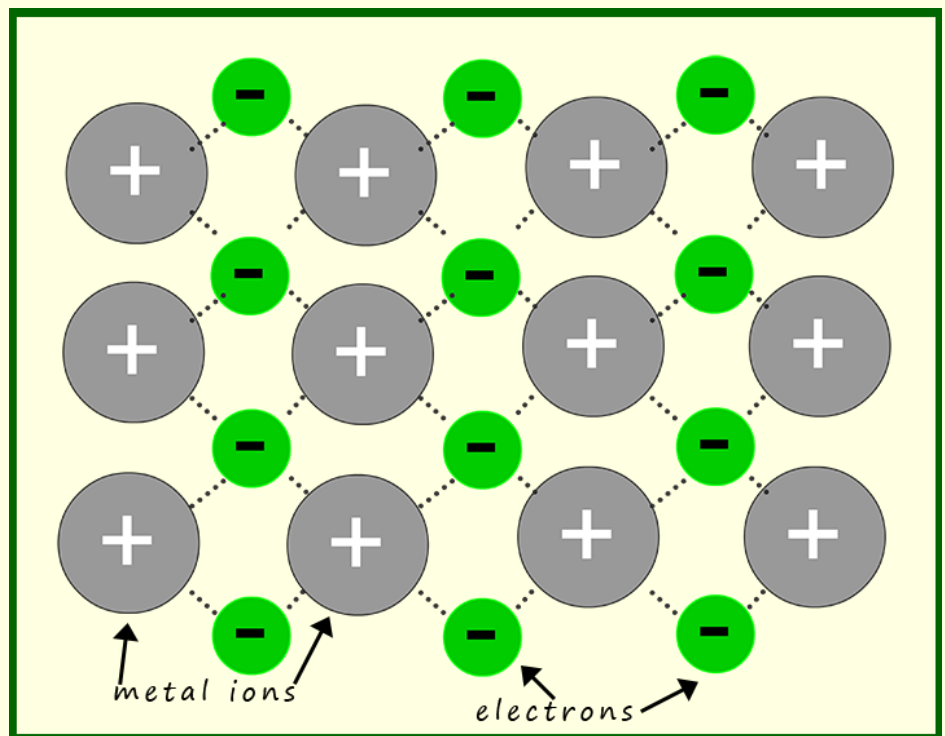
Metallic bonding

Answer all the questions below then check your answers.

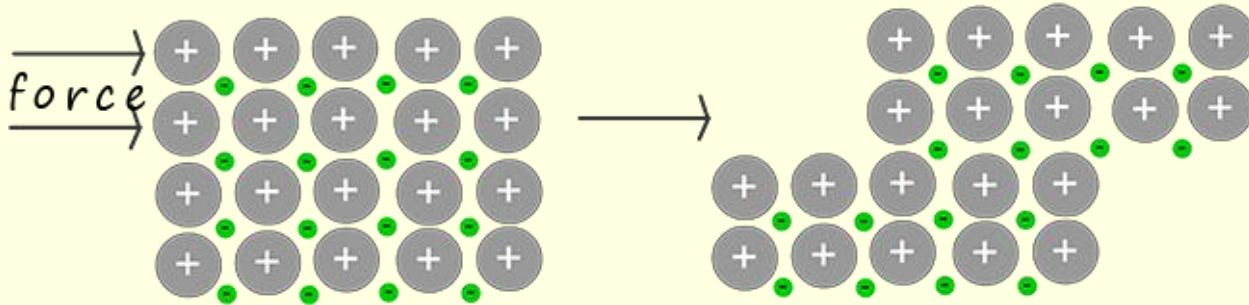
1. Make a list of the common properties of metals and explain what features of their structure and bonding gives rise to this property. The first one has been done for you.
 - Metals have high melting and boiling points. This is due to the fact that they have giant structures with lots of strong metallic bonds holding the metal ions in place.

2. The image opposite represents how scientists believe the metal ions are arranged in a metal.

- a. Describe the structure of metals and explain what a metallic bond is.



- b. Metals are ductile, this means that they can be pulled and stretched into wires. They are also malleable. Use your knowledge of metallic bonding to explain how the layers of ions in a metal structure are able to slide when a force is applied to them.



- c. Explain why aluminium is a better conductor than magnesium metal.
3. What factors influence the strength of metallic bonds?
- Explain how a metallic bond is different from an ionic bond.
 - Explain why sodium has a lower melting point than aluminium.

Metallic bonding

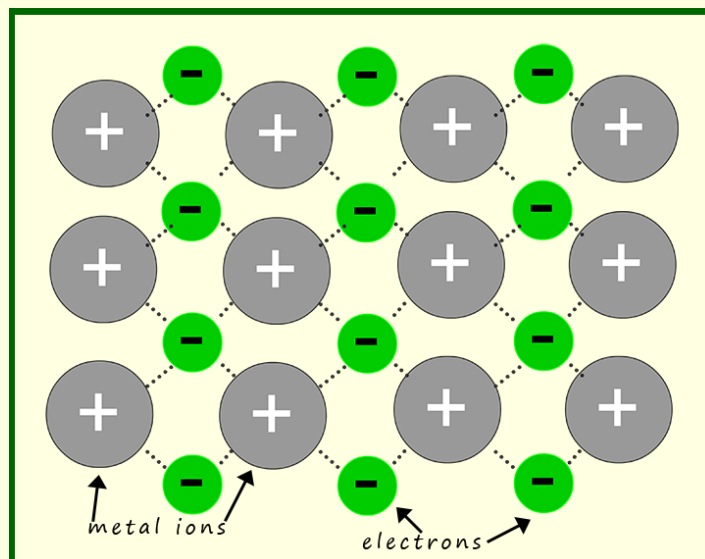
Answers

1. Make a list of the common properties of metals and explain what features of their structure and bonding gives rise to this property. The first one has been done for you.
 - Metals have high melting and boiling points. This is due to the fact that they have giant structures with lots of strong metallic bonds holding the metal ions in place.
 - Metals are dense. The ions in the metal structure are tightly and closely packed together.
 - Metals are good conductors of heat and electricity. In a metal the atoms lose their outer shell electrons, these electrons become delocalised and are free to move around the structure. This leaves a structure of positive ions surrounded by a sea of delocalised electrons. These delocalised electrons are able to transfer electrical and thermal energy through the structure.
 - Metals are ductile, this means that they can be pulled out into wires. The layers of positive metal ions inside the metal structure are attracted to the free moving delocalised electrons. This is a metallic bond. However these bonds are fleeting or temporary, they are continually breaking and reforming. This means that if a force is applied to the layers they will slide due to the fact that the metallic bonds are able to break, however when the force is reduced the metallic bonds will simply reform.
 - Metals are malleable – this means they can be hammered and beaten into shape. The reason for this is similar to that given for the fact that they are ductile.

- Metals are shiny. The delocalised electrons are able to reflect light. This makes the metal shiny.

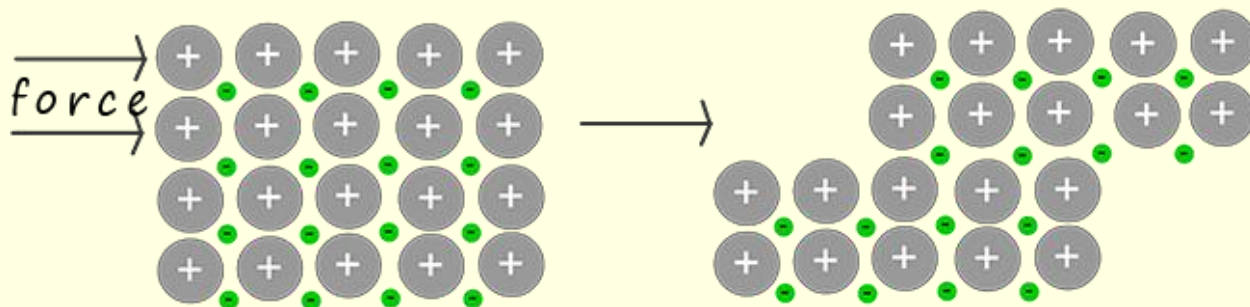
2. The image opposite represents how scientist believes the ions are arranged in a metal.

a. Describe the structure of metals and explain what a metallic bond is.



Metals consist of a giant structure of positive ions. These ions form when the metal atoms lose their outer shell electrons. These electrons become delocalised and form a "sea of electrons" surrounding the metal ions. The metal ions, all being positively charged, you might imagine they would all simply repel each other. However the electrons are attracted to these metal ions and this attraction is called a metallic bond. The ions will be attracted to the electrons around them. It is important to realise that the electrons are in constantly motion and move freely through the structure. This means that the metallic bonds are constantly breaking and reforming. This constant bond breaking and reforming is responsible for many of the properties of metals.

- b. Metals are ductile, this means that they can be pulled and stretched into wires. They are also malleable. Use your knowledge of metallic bonding to explain how the layers of ions in a metal structure are able to slide when a force is applied to them.



The explanation for this is given above!

- c. Explain why aluminium is a better conductor than magnesium metal.

Aluminium has 3 electrons in its valence shell. These 3 electrons will become delocalised throughout the metal structure, magnesium has only 2 electrons in its valence shell, less electrons means that it will be a poorer electrical conductor than aluminium.

3. What factors influence the strength of metallic bonds?

- The size of the metal cation – the smaller and more highly charged the metal cation the stronger will be the metallic bond it forms.

- a. Explain how a metallic bond is different from an ionic bond.

In an ionic bond the electrons are completely transferred from the metal to the non-metal atom, resulting in the formation of positively and negatively charged

ions. These ions form a giant structure where the ions are held in rigid fixed positions. In a metallic bond the metal atoms lose the electrons in their valence shell, this forms positive metal ions but the electrons form a sea of negative charge which moves freely through the giant structure of metal cations. The attraction of the negatively charged electrons to the metal cations is only fleeting and temporary.

b. Explain why sodium has a lower melting point than aluminium.

Sodium is an alkali metal in group 1 so only has 1 electron in its valence shell, whereas aluminium is a group 3 metal with 3 electrons in its valence shell. The attraction of the delocalised electrons to the sodium cation, Na^+ will be much weaker than the attraction of the delocalised electrons to the Al^{3+} cation. This means the metallic bonds in aluminium will be stronger than in sodium so aluminium has a higher melting point.