Metallic Bonding

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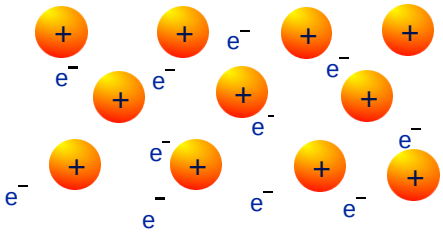
Metallic Bonding

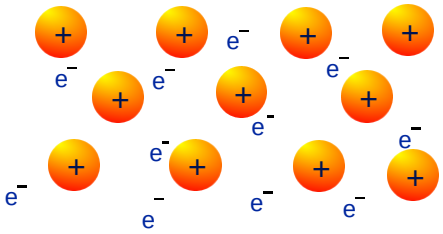
- Metallic Bonding is the type of bonding found in metallic crystals.
- A metallic solid can be pictured as a three-dimensional **lattice** of **positive ions** with **delocalised outer-shell electrons** moving freely throughout the crystal.
(delocalised: means not permanently linked to one atom)
- Sea of mobile electrons cement the metal ions tightly into a lattice



KEY

Key points on metallic bonding

- The positive ions are formed when the outer electrons become detached from the atom , leaving a positive ion behind. The electrons that leave the atom, join in the sea of delocalised electrons. The metal ions are arranged in a lattice



The metallic bond is the attraction between the metal positive ions and the delocalised electrons

KEY

Factors affecting the strength of metallic bonds

The three main factors that effect the metallic bond are:

1. Number of protons/ Strength of nuclear attraction.

   (The more protons the stronger the force of attraction between the positive ions and the delocalised electrons)

2. Number of delocalised electrons per atom

   The more delocalised electrons the stronger the force of attraction between the positive ions and the delocalised electrons

3. Size of atom.

   The smaller the atom, the stronger the force of attraction between the positive ions and the delocalised electrons.

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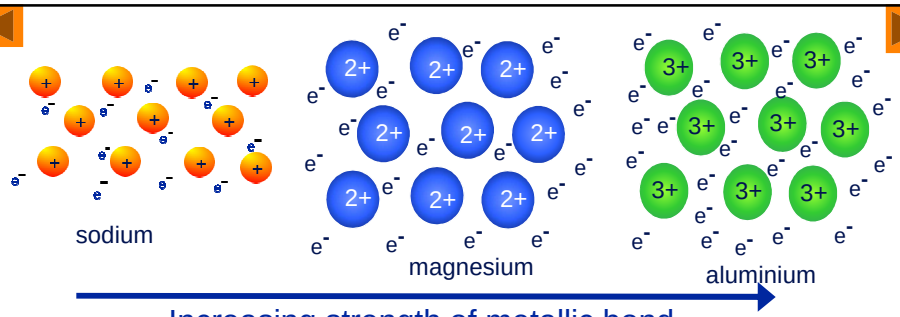

The strength increases because:

- The atoms have more protons
- There are more delocalised electons per atom

Group1 elements have 1 electron in their outer shells and so donate 1 electron to the sea of electrons.
Group 2 elements donate 2 electron per atom.
Group 3 elements donate 3 electrons per atom

- The atoms/ions are smaller

There is therefore a greater force of attraction between the positive ions and the delocalised electrons

KEY

Typical properties of metals

- High melting points
- Malleable
- Conductors of electricity
- Shiny (due to delocalised electrons causing light to be reflected)

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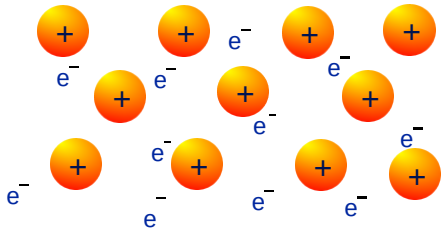
Sea of Electrons

- Electrons are free to move through the solid.



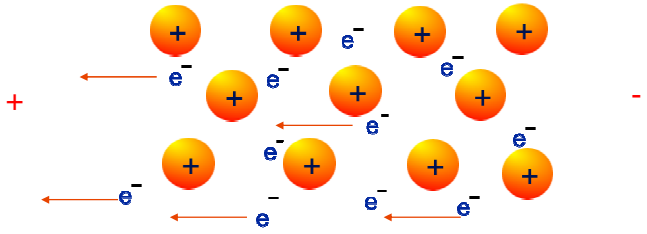
The fluid-like movements of the outer-shell electrons make metals good conductors of heat and electricity

KEY

Conducting Electricity

Metals can conduct electricity because the sea of electrons is mobile and free to move.

The electrons, which are charge carriers, will migrate towards the positive end of a potential difference applied across the metal



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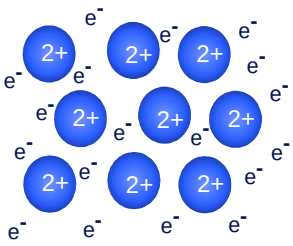
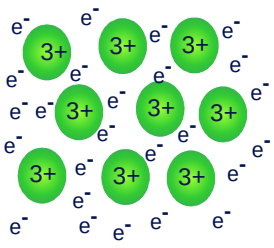
Metallic Bonding

Aluminium will conduct electricity more than magnesium because it has more electrons delocalised .



magnesium



aluminium

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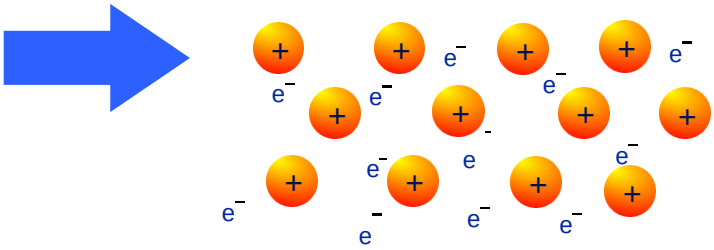
Malleable

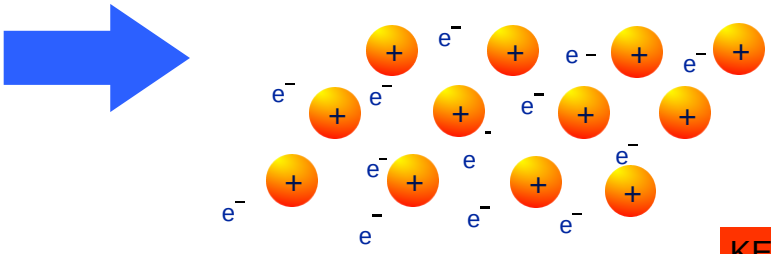
Metals are malleable and can easily change shape



KEY

Malleable

- The positive ions in the lattice are all identical. So the planes of ions can slide easily over one another
- attractive forces in the lattice are the same whichever ions are adjacent and remain the same throughout the lattice



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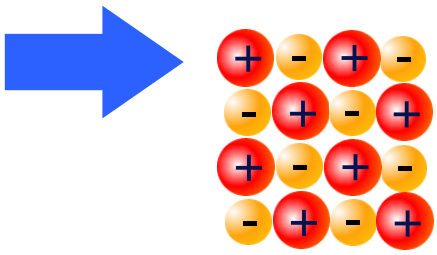
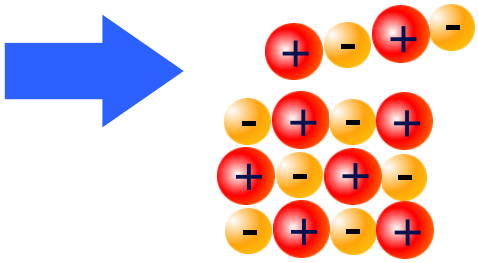
Comparison: Ionic solids are brittle



Ionic solids are brittle

Strong Repulsion between same charged ions breaks crystal apart.



Exam Question

1. The table below provides some information regarding the metals sodium, magnesium and iron.

	sodium	**magnesium**	**iron**
Melting point /K	371	923	1808
Metallic radius /nm	0.186	0.160	0.126
Crystal structure	body-centred	close-packed	body-centred

(a) Describe the bonding found in metals.

(b) Use data from **table above** and your knowledge of the bonding in these metals to explain why the melting point of magnesium is higher than that of sodium.