



Cambridge (CIE) IGCSE Chemistry



Your notes

Properties, Uses & Alloys of Metals

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- * Properties of Metals
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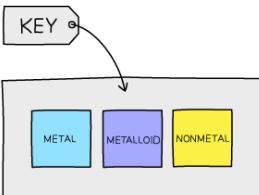


Physical properties of metals & non-metals

- The Periodic Table contains over 100 different elements
- They can be divided into two broad types:
 - Metals**
 - Non-metals**
- Most of the elements are metals and a small number of elements display properties of both types
 - These elements are called **metalloids** or **semimetals**

1/I		2/II																				0/VIII		
		H																			He			
Li	Be																							
Na	Mg																							
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se									
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe							
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn							
Fr	Ra	Ac																						

Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr



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The metallic character diminishes moving left to right across the Periodic Table

Properties of metals

- Conduct **heat** and **electricity**
 - This is because metals have delocalised electrons that are able to move through the metal structure



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- Are **malleable** (can be hammered and made into different shapes) and **ductile** (can be drawn into wires)
 - This is because the layers of positive metal ions, in the metal structure, are able to slide over each other
- Usually have **high** melting and boiling points
 - This is because there is a strong electrostatic attraction between the positive metal ions and delocalised electrons (**metallic bond**)
 - This strong attraction / bond requires lots of energy to break

Properties of non-metals

- Do **not** conduct heat and electricity
 - This is because all of the electrons are involved in covalent bonding
 - One exception to this is **graphite**
- Are **brittle** when solid and easily break up
 - They are not malleable or ductile
 - One exception to this is **graphite**
- **Low** melting and boiling points
 - Many non-metals are gases at room temperature
 - This is because they have weak forces between molecules
 - These weak intermolecular forces do not require a lot of energy to overcome
 - Exceptions to this include **diamond** and **silicon(IV) dioxide**

Chemical properties of metals

- The chemistry of metals is studied by analysing their reactions with water, dilute acid and oxygen
- Based on these reactions, a **reactivity series** of metals can be produced

Reactions of metals with water

- Some metals react with water, either warm or cold, or with steam
- Metals that react with cold water form a metal hydroxide and hydrogen gas



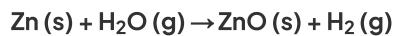
- For example, calcium:



- Metals that react with steam form a metal oxide and hydrogen gas



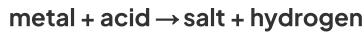
- For example, zinc:



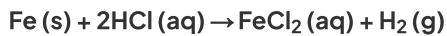
Your notes

Reactions of metals with acids

- Most [metals react with acids](#), such as HCl
- When acids and metals react, the hydrogen atom in the acid is replaced by the metal atom to produce a salt and hydrogen gas



- For example, iron:



Reactions of metals with oxygen

- Unreactive metals, such as gold and platinum, do not react with oxygen
- Some reactive metals, such as the alkali metals, react easily with oxygen
- Copper and iron can also react with oxygen, although much more slowly
- When metals react with oxygen a metal oxide is formed



- For example, copper:





Uses of metals

What is aluminium used for?

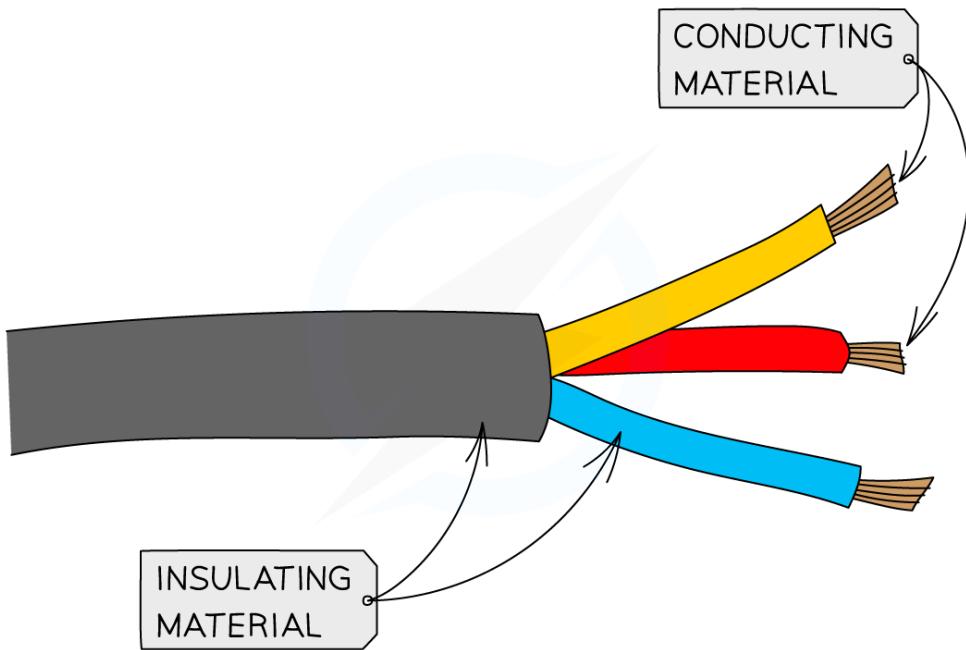
- Aluminium sits above hydrogen in the reactivity series, which means that it is a reactive metal
 - Aluminium quickly reacts with oxygen to form a protective layer of aluminium oxide, which is why aluminium appears to be unreactive

Uses of aluminium

Use	Property
aeroplane bodies	high strength-to-weight ratio, low density
overhead power cables	good electrical conductor, low density
saucepans	good thermal conductor
food cans	non-toxic, resistant to corrosion and acidic foods

What is copper used for?

- Copper sits below hydrogen in the reactivity series, which means it is an unreactive metal
- The uses of copper relate to its properties
- For example, it is an excellent electrical conductor and ductile so is used in wiring


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Copper is usually the metal inside electrical wires due to it's high conductivity

Uses of copper

Use	Property
electrical wiring	very good conductor of electricity and ductile
pots and pans	very good conductor of heat, unreactive, malleable
water pipes	non-toxic, unreactive (does not react with water) and malleable
surface in hospitals	antibacterial properties



Properties & uses of alloys

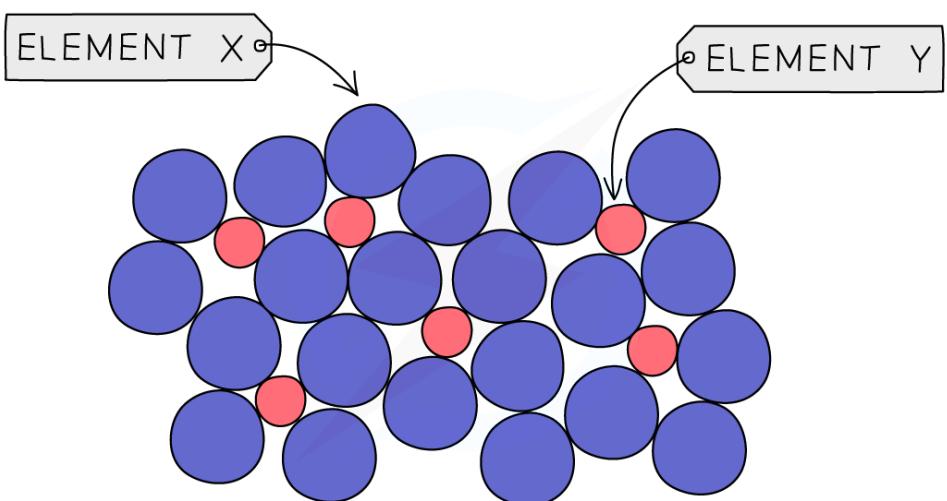
- An **alloy** is a **mixture** of a metal with other elements
 - Most alloys contain more than one metal
 - Some alloys contain non-metals

Properties and uses of alloys

- Two examples of alloys are:
 - **Brass** - an alloy of copper and zinc and is much stronger than either metal
 - It is used in musical instruments, ornaments and door knobs
 - **Stainless steel** - an alloy of iron and other elements, for example, chromium, nickel and carbon
 - It is used in cutlery because of its hardness and resistance to corrosion / rusting
- Other alloys include:
 - Iron with tungsten - extremely hard and resistant to high temperatures
 - Iron with chromium / nickel - resistant to corrosion
 - Aluminium with copper, manganese and silicon - the alloy is stronger but still has a low density, which makes it ideal for aircraft body production
- Alloys often have **properties** that are **different** to the metals they contain
 - For example, they can be:
 - Stronger
 - Harder
 - Resistant to corrosion / extreme temperatures
 - These enhanced properties can make alloys more useful than pure metals

The structure of an alloy

- Alloys have a different structure to **metals**
 - Metals have a regular arrangement of ions
 - Alloys have an irregular arrangement of atoms



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The regular arrangement of a metal lattice structure is distorted in alloys



Examiner Tips and Tricks

- Alloys are mixtures of substances.
- They are not chemically combined, which means that alloys are not compounds.
- Questions on this topic often give you a selection of particle diagrams and ask you to choose the one which represents an alloy.
- It will be the diagram with uneven-sized particles and distorted layers or rows of particles.

Explaining the properties of alloys

Extended tier only

- Alloys typically contain atoms of **different** sizes
- This **distorts** the normally regular arrangements of atoms in metals
 - The regular arrangement in a metal is layers of positive ions in a sea of delocalised electrons
- The distortion makes it more difficult for the layers to **slide** over each other
- So, alloys are usually harder / stronger than pure metals