

# Cambridge (CIE) IGCSE Chemistry



Your notes

## Properties, Uses & Alloys of Metals

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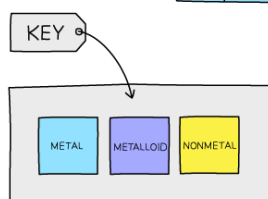


## Physical properties of metals & non-metals

- 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																	3/III	4/IV	5/V	6/VI	7/VII	0/VIII
Li	Be																	B	C	N	O	F	Ne
Na	Mg																	Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr						
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



- 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



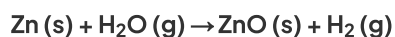
- For example, calcium:



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



- For example, zinc:



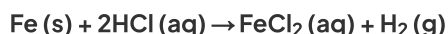
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## Reactions of metals with acids

- 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

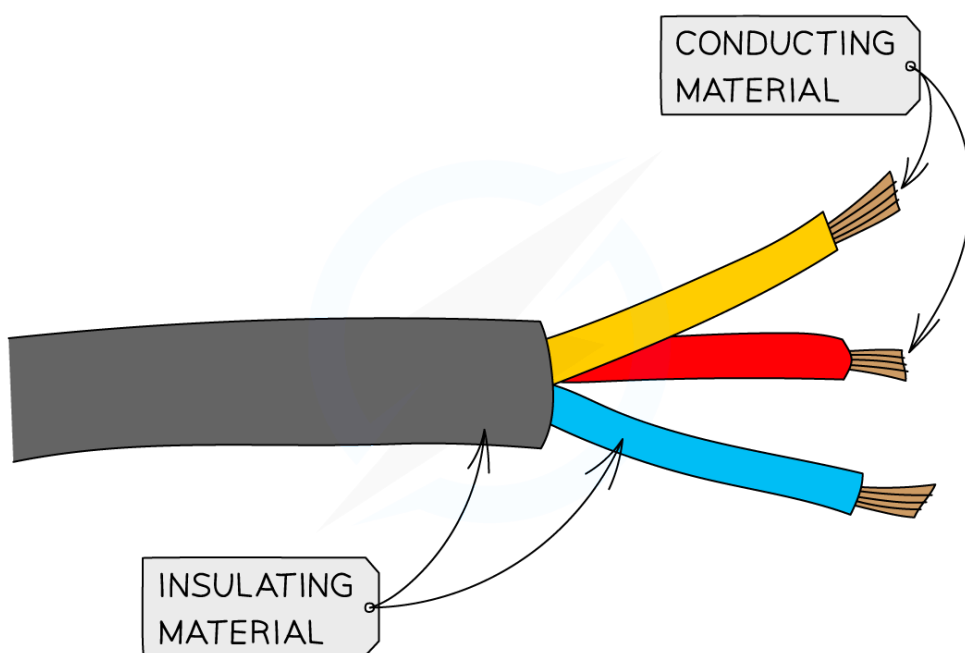
Use	Property
aeroplane bodies	high strength-to-weight ratio, low density
overhead power cables	good electrical conductor, low density
saucepans	good thermal conductor
food cans	non-toxic, resistant to corrosion and acidic foods

## 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 its 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

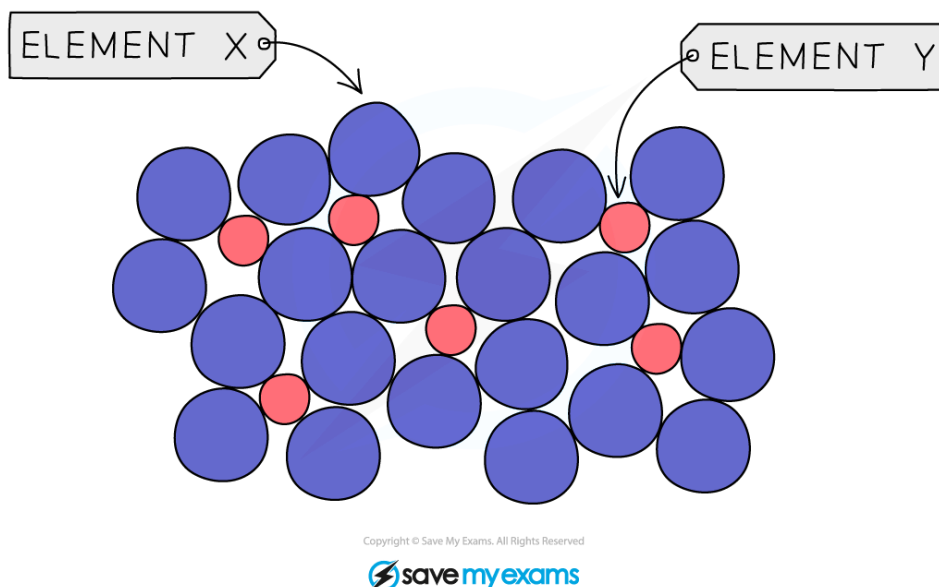
- An **alloy** is a **mixture** of a metal with other elements
  - Most alloys contain more than one metal
  - Some alloys contain non-metals

## 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