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C10 METALS

C10.1 Properties of metals

Metals are solids with:

- high melting points
- high boiling points
- malleable
- good conductors of heat
- good conductors of electricity

Metallic bonding is a lattice of positive ions in a 'sea of electrons'.

- When a voltage is applied, delocalised electrons move through the metal lattice towards the positive pole of the cell.
- Positive ions are arranged in layers. When a force is applied, layers slide over each other. The attraction between the metal ions and the electrons act in any direction. When layers slide, new bonds are formed - a new shape.

Alloys are mixtures of a metal with other elements.

Brass is an alloy of copper and zinc.

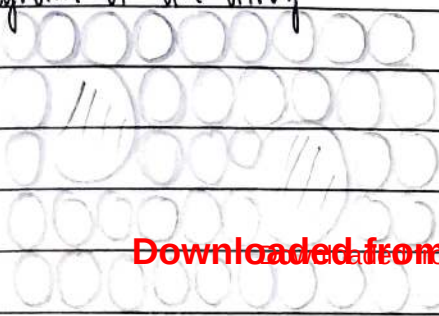
- It is stronger than copper, but still malleable

Metals are made into alloys to improve their strength, hardness or resistance to corrosion.

Stainless steel is an alloy of iron, chromium and nickel.

- It does not rust like iron.

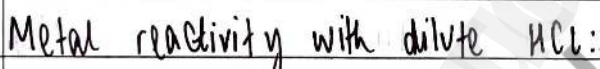
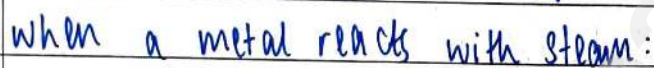
Diagram of an alloy



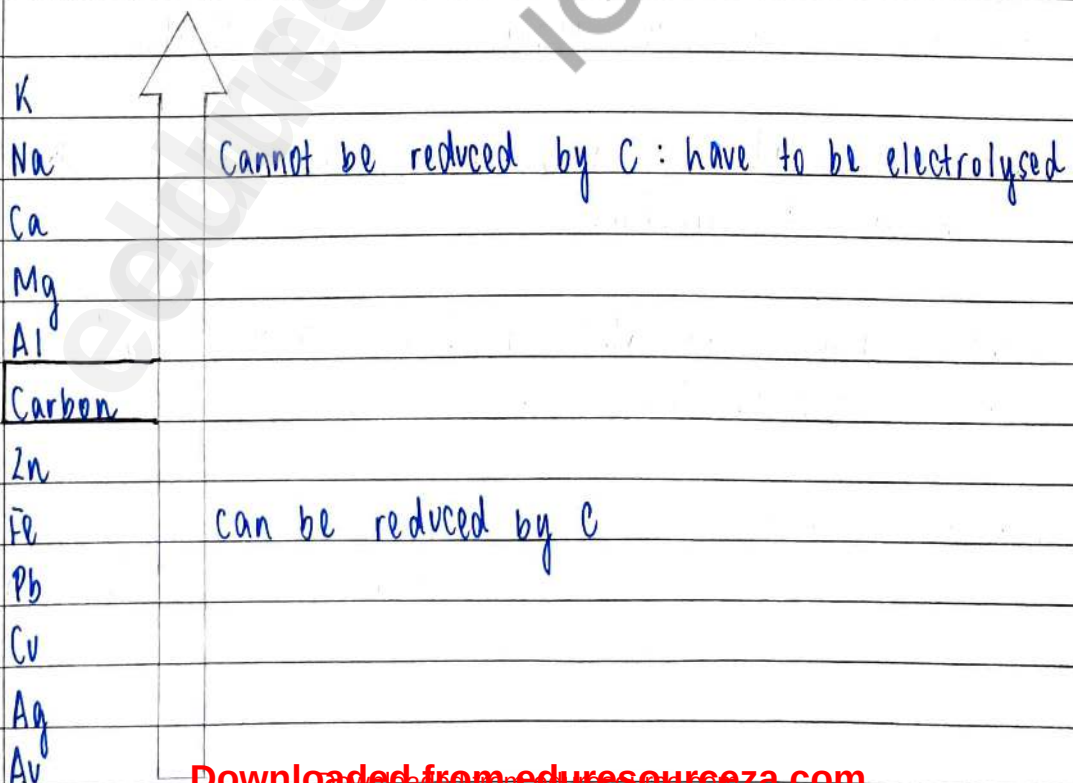
Layers do not slide easily

Metal reactivity with water:
with steam:

when a metal reacts with water:



Reduction of oxides with carbon:



The position of a metal in the reactivity series is by the metal's tendency to form its positive ion by having a reaction with:
aqueous ions of other metals
oxides of other metals

C10.3 Extraction of metals from their ores

Carbon is used to reduce oxides of metals below it in the reactivity series.

Carbon is usually in the form of coke, which is coal with some impurities removed.

A blast furnace is a furnace into which air is blown and in which a metal oxide is reduced using carbon.
Hematite is the ore of iron.

Raw materials:

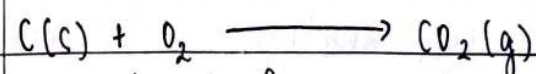
- Hematite
- Coke
- Limestone
- Air

Step 1:

Add hematite, coke and limestone to the top of the furnace.

Step 2:

Hot air is blown at the bottom.

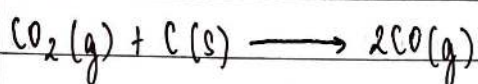


coke burns forming CO_2

heat is released, heating the furnace

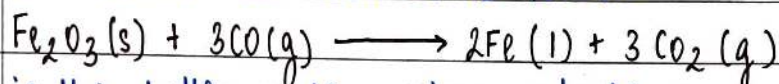
Step 3:

CO_2 reacts with coke to form carbon monoxide

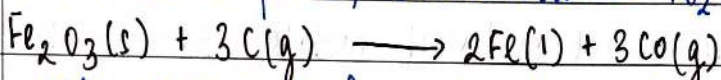


Step 4:

CO reduces the iron oxide to iron



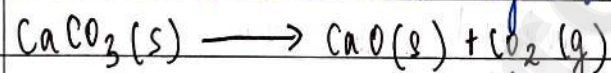
in the hotter parts, carbon reduces Fe_2O_3 directly:



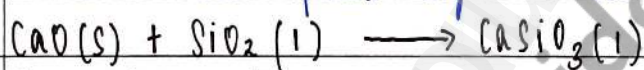
waste gases exit from the top and heat air going into the furnace.

Step 5:

Silicon oxide is removed by reacting with lime.



limestone decomposes by the heat



The calcium silicate is a slag.

It runs down and as it has lower density than iron, it does not mix with it.

Step 6:

iron runs down and is taken out at intervals.

Step 7:

hot waste gases are recycled to avoid pollution

Aluminium is extracted from its ore, bauxite, by electrolysis.

Metals above carbon cannot be extracted by heating with carbon.

Metal ores are a finite resource, hence, they need to be recycled.
(metals need to be recycled)

C10.4 Uses of metals

Uses of aluminium:

- aircraft parts
 - because of strength and low density
- food containers
 - because of resistance to corrosion.

The apparent unreactivity of aluminium is due to an unreactive oxide layer that forms on its surface.

Uses of mild steel:

- car bodies
- machinery
 - soft, malleable and does not wear away

Uses of stainless steel:

- chemical plant
- cutlery
 - very strong and resistant to corrosion

Uses of zinc:

- galvanising steel
 - prevents rusting (used for roofing)
- making brass
 - strong, does not corrode (used for musical instruments)