Metals

Electronic structure

- A lattice of positive ions in a sea of electrons
- Attraction between cations and electrons result in strong metallic bonding

Properties

- **Malleable** – the layers of metal ions are able to slide over each other
- **Ductile** – due to weak forces between the metal ions layer, allowing the pulling of the metal without breaking.
- **Heat and electrical conductivity** – the mobile sea of electrons allow the current and heat to be carried away from the source easily

Metal alloys

- A mixture of a metal with other elements – non metals and metals
- **Stainless steel** – mixture of iron with carbon and chromium
- **Brass** – mixture of copper and zinc
- **Bronze** – mixture of copper and tin

Physical Properties (Metal alloys)

- Metal alloys retain same chemical properties but different physical properties from its constituent elements
- Physical properties

  -1)harder

  -2) more brittle

  -3) corrosion resistant (stainless steel)

The reason being the introduction of other elements into the metal lattice disrupts the orderly arrangement and makes the metal ions layers less easy to slide over each other and break more easily for properties (1) and (2)

Reactivity series

- In order of decreasing reactivity

  - Na (sodium) > Ca (Calcium) > Mg (Magnesium) > Zn (Zinc) > Fe (Iron) > Pb (lead) > H+ (Hydrogen ion) > Cu (Copper)

Metal	Reactivity with water	Reactivity with steam
Na	Reacts vigorously with cold water	Yes vigorously
Calcium	Reacts slowly with water	Yes
Magnesium	Reacts very slowly with hot water. Reacts with steam when heated to form oxides and hydrogen	Yes
Zinc, Iron	Do not react with cold or hot water. Reacts with steam to form hydrogen and metal oxides. In the presence of Oxygen, Iron (III) oxide (rust is formed)	Yes
Pb (lead) and Cu (Copper)	Do not react with cold or hot water or steam	No

Displacement of metal ions in aqueous solution and oxides

- More reactive metals will displace less reactive metals in solutions and their oxides

Heat stability of carbonates

- Carbonates of more reactive metals are more stable to heat.

Extraction of metal ores

- Ores of reactive metals like Na, Magnesium can only be extracted by electrolysis of the molten ores
- Ores of less reactive metals like Fe or Cu can be extracted by heated charcoal or hydrogen

Metal recycling

- Metals are present in the earth crust as finite resources, and extraction of these metals require huge amount of energy, hence the need to recycle them as recycling is more cost effective.

Metal recycling advantages

- Metal recycling reduces toxic waste being produced from metal ores mining which can result in environmental pollution.
- Economically , the cost of recycling is much lesser than extracting the metals from the ores

Iron ore extraction process

- Haematite (Iron oxide) is reduced by heated charcoal (coke)
- $C + O_2 = CO_2$
- $CO_2 + C = 2CO$
- $2Fe_2O_3 + 6CO = 6CO_2 + 4Fe$
- Calcium carbonate (limestone) is used to remove acidic silica impurities from the iron oxides, forming metal slag
- $CaCO_3 = CaO + CO_2$
- $CaO + SiO_2 = CaSiO_3$

Rusting of iron

- Requires the presence of water and O2.
- Boiled water has little oxygen and the Iron nail does not rust in it
- The iron can be protected from rusting by painting over the iron surface, or applying a layer of grease over it, or by coating it with zinc metal (galvanising)

Sacrificial protection

- Sacrificial protection is whereby a more reactive metal is attached to a less reactive one and protects the less reactive metal as it has a higher tendency to corrode. Magnesium attached to Iron on ship hull in sea water.