The Reactivity Series

The reactivity series is a empirically determined list of _____ arranged in order of their relative reactivity, from the most to the least reactive.

magnesium metal (Mg)

magnesium oxide (MgO)

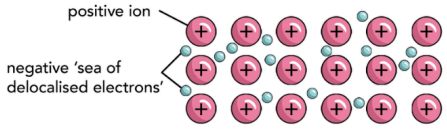
Notes for this chapter

- Metals can only undergo _____ because they tend to lose 1, 2, or 3 valence electrons to achieve a full electron shell configuration; metals do **not** undergo reduction. Metal ions in c_____ can undergo reduction. e.g. magnesium in Mg can undergo oxidation but magnesium in MgO can undergo reduction
- Metals are elements and do not exist as compounds. But metals can form compounds when they bond with non-metals (but they will not be called metals) e.g. Cu is a metal but CuO, Cu^{2+} are not metals (esp in ionic equations, the metal will be a solid element)

properties, structure & bonding of metals

metallic bonding is within the metal itself, between the cation and 'sode'

Metals have a giant metallic lattice structure (structure) with strong electrostatic forces of attraction between the positive metal cations and the negative 'sea of delocalised electrons' (bonding).



structure of a metal

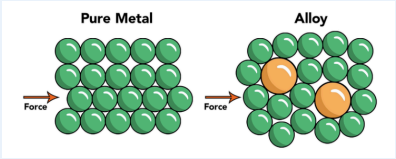
PROPERTIES	KEY POINT	STRUCTURE
high mp / bp (except group 1 metals)		strong metallic **bonds** require a lot of energy to overcome
malleable / ductile *ductile:* can be drawn out into thin wires without breaking *malleable:* can be shaped without breaking		**layers** of metal atoms **slide** over one another easily without breaking the metallic bond
conductors of electricity		**'sode'** acts as mcc
conductors of heat		**'sode'** can move rapidly to transfer energy

alloys

an alloy is a **m**_____ of at least one metal and another metal or nonmetal
an alloy is a **mixture** of at least two e_____, one of which must be a metal

Benefits of alloys over pure metals

- stronger and harder than pure metals
- more resistant to c_____ than pure metals



Why are alloys harder and stronger than pure metals?

- Alloys are **mixtures** of metal atoms of _____ _____
- that **disrupt the regular arrangement** of the metal atoms
- and make it more difficult for the **layers** of metal atoms to **slide** over one another when a force is applied

Examples of alloys

- steel (carbon steel: iron and carbon, stainless steel: iron, carbon, chromium, nickel)
- brass (copper and zinc)

reactions and using the reactivity series to predict reactions

The reactivity series is used to predict how vigorous the oxidation of metals can be.
To predict the reaction of metal compounds (which are not metals), the reactivity series must be adapted (considered in reverse).

REACTIONS	REAGENT	EQUATION	METALS THAT REACT
oxidation of **metals**	cold water	metal + H_2O (*l*) → metal hydroxide + H_2	Mg & 3 above
	steam	metal + H_2O (g) → metal oxide + H_2	Mg & 3 below
	acid	metal + acid → salt + H_2	above hydrogen
reduction of **metal oxides** • also known as extraction • more reactive metals are more difficult to extract • if the metal cannot be extracted by carbon or hydrogen, perform electrolysis	carbon	metal oxide + C → metal + CO_2	Zn and below
	hydrogen	metal oxide + H_2 → metal + H_2O	Fe and below
	more reactive metal	A + BO → B + AO	A must be a more reactive metal than B
metal displacement	aq metal compound	A + BC → B + AC	A must be a more reactive metal than B
thermal decomposition of **metal carbonates**	heat* not a reagent	metal carbonate → metal oxide + CO_2	exceptions: K_2CO_3, Na_2CO_3, $AgCO_3$

POTASSIUM
SODIUM
CALCIUM
MAGNESIUM
ALUMINIUM
ZINC
IRON
LEAD
HYDROGEN
COPPER
SILVER
GOLD

rusting

Rusting is the corrosion of _____ by air (oxygen) and water to form hydrated iron (III) oxide.

$$4Fe\ (s) + 3O_2\ (g) + 2xH_2O\ (l) \rightarrow \underbrace{2Fe_2O_3 \cdot xH_2O(s)}_{\text{rust}}$$

How to prevent rusting?

1. **Using a protective layer** e.g. paint, plastic, grease, another metal
3. **Using an alloy** e.g. stainless steel
2. **Sacrificial protection**
   - the more reactive metal oxidises and loses electrons more readily to the less reactive metal
   - the less reactive metal receives these electrons, which makes it less likely to oxidise
   - the more reactive metal **corrodes in place of** the less reactive metal
     i. **Galvanising**: applying a protective coating of _____ onto iron/steel
     ii. Attaching a piece of zinc or magnesium onto iron or steel
4. **Submerge completely in inert liquids** e.g. oil