4 Chemical changes

Reactivity of metals

- Metals react with **oxygen** to produce **metal oxides.**
- The reactions are oxidation reactions because the metals gain oxygen.
- Reduction involves the loss of oxygen.
- Oxidation is the loss of electrons and reduction is the gain of electrons. OIL RIG (oxidation is loss reduction is gain **of electrons**. **(HT)**
- When metals react with other substances the metal atoms form **positive** ions.
- The reactivity of a metal is related to its tendency to form positive ions.
- Metals can be arranged in order of their reactivity in a reactivity series.
- A **more** reactive metal can displace a **less** reactive metal from a compound.
- Unreactive metals such as gold are found in the Earth as the metal itself but most metals are found as compounds that require chemical reactions to extract the metal.
- Metals **less** reactive than carbon can be extracted from their oxides by **reduction with carbon.**
- Metals **more** reactive than carbon are extracted using **electrolysis**.

Reactions with acids

- Metal + Acid -> Salt + Water (MASH)
- Acid + carbonate -> Salt + Water + Carbon Dioxide.
- Acid + Alkali (base) -> Salt + Water
- To name the salt take the positive ion (usually the metal) and then change the name of the acid:
- Hydrochloric acid – chloride
- Nitric acid – nitrate
- Sulfuric acid – sulfate
- **Acids** produce **hydrogen ions (H^+)** in aqueous solutions.
- Aqueous solutions of **alkalis** contain **hydroxide ions (OH^-).**
- A solution with **pH 7 is neutral**.
- **Acids** have pH values of **less than 7.**
- **Alkalis** have pH values **greater than 7**.
- In neutralisation reactions between an acid and an alkali, hydrogen ions react with hydroxide ions to produce water.
- $H^+ (aq) + OH^- (aq) \rightarrow H_2O (l)$.

- **HT ONLY**
- A **strong** acid is **completely ionised** in aqueous solution. Examples of strong acids are hydrochloric, nitric and sulfuric acids.
- A **weak** acid is only **partially ionised** in aqueous solution. Examples of weak acids are ethanoic, citric and carbonic acids.
- For a given concentration of aqueous solutions, the stronger an acid, the lower the pH.
- As the pH decreases by one unit, the hydrogen ion concentration of the solution increases by a factor of 10.

Electrolysis

•When an **ionic compound** is melted or dissolved in water, the ions are free to move about within the liquid or solution. These liquids and solutions are able to conduct electricity and are called electrolytes.
• Passing an electric current through electrolytes causes the ions to move to the electrodes.
•**Positively** charged ions move to the **negative** electrode (the **cathode**),
•**Negatively** charged ions move to the **positive** electrode (the **anode**).

•**PANiC (Positive Anode, Negative is Cathode)**

•If you have a simple ionic compound and melt it the **positive metal cation** will go the **negative cathode**. The **negative non metal anion** will go to the **positive anode**.

•**Cations are positive. Anions are negative.**

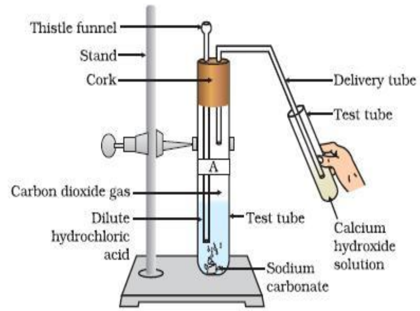
• Aluminium is manufactured by the electrolysis of a molten mixture of aluminium oxide and cryolite using **carbon** as the positive electrode **(anode).**

•When the ionic compound is dissolved in water:
• At the negative electrode **(cathode), hydrogen** is produced if the metal is more reactive than hydrogen.
• At the positive electrode **(anode), oxygen** is produced unless the solution contains **halide ions (chloride, bromide etc)** when the **halogen** is produced.
• This happens because in the aqueous solution water molecules break down producing **hydrogen ions** and **hydroxide ions** that are discharged.
•HT ONLY
•During electrolysis, at the **cathode** (negative electrode), positively charged ions **gain** electrons and so the reactions are **reductions**.
•At the **anode** (positive electrode), negatively charged ions **lose** electrons and so the reactions are **oxidations.**
•Reactions at electrodes can be represented by half equations, for example:
•$2H^+ + 2e^- \rightarrow H_2$
•$4OH^- - 4e^- \rightarrow O_2 + 2H_2O$

Example Apparatus

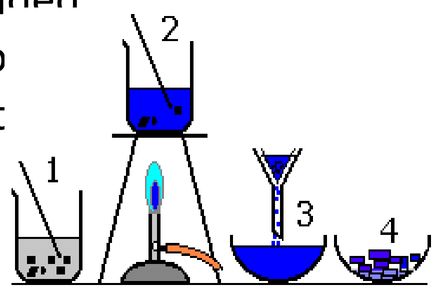
Acid + Carbonate

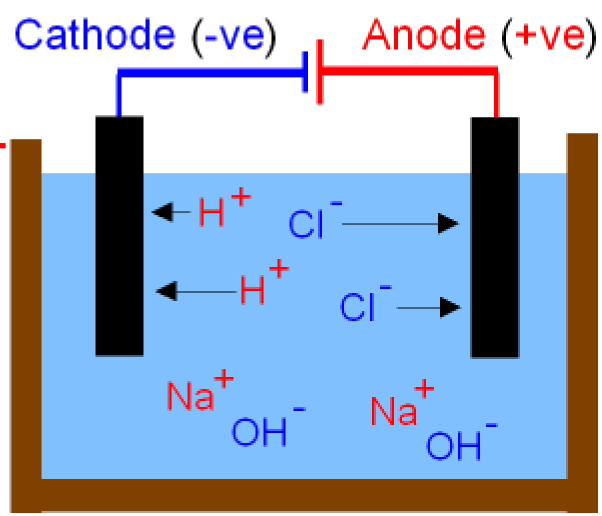
Limewater (calcium hydroxide can be used To show Co_2 is produced



Acid + Metal Oxide

- Excess of metal oxide added
- Need to heat the solutio to ensure as acid fully react with available metal oxide particles
- Then filter to remove Excess metal oxide



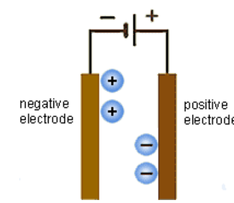


Required practical

Example Apparatus

Molten compounds or less reactive salt solutions

- Positive ions to negative electrode. Negative ions to positive electrode.



More reactive metal solutions e.g. Sodium Chloride solution (Brine)

- If the metal is more reactive than Hydrogen
- Hydrogen is produced at the Negative electrode (instead of the metal).
- Metal hydroxide is produced In the solution.