Reaction of metals with oxygen:

When a metal reacts with oxygen, we form **metal oxide**:

Magnesium + Oxygen --> **Magnesium oxide**

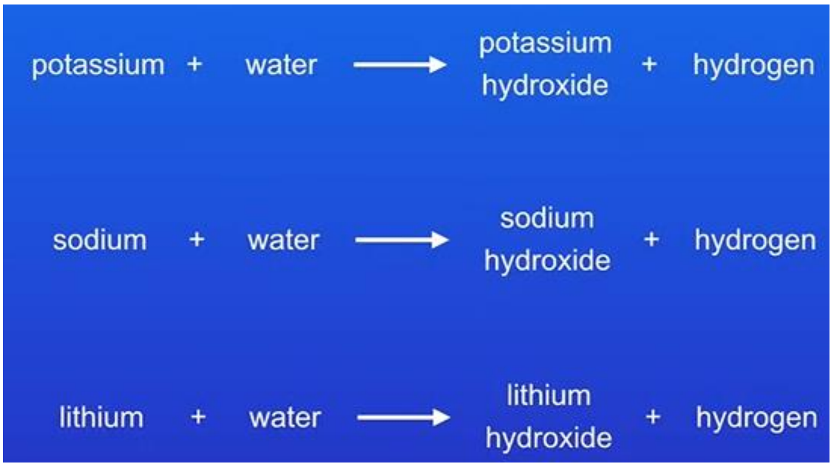
Iron + Oxygen --> **Iron oxide**

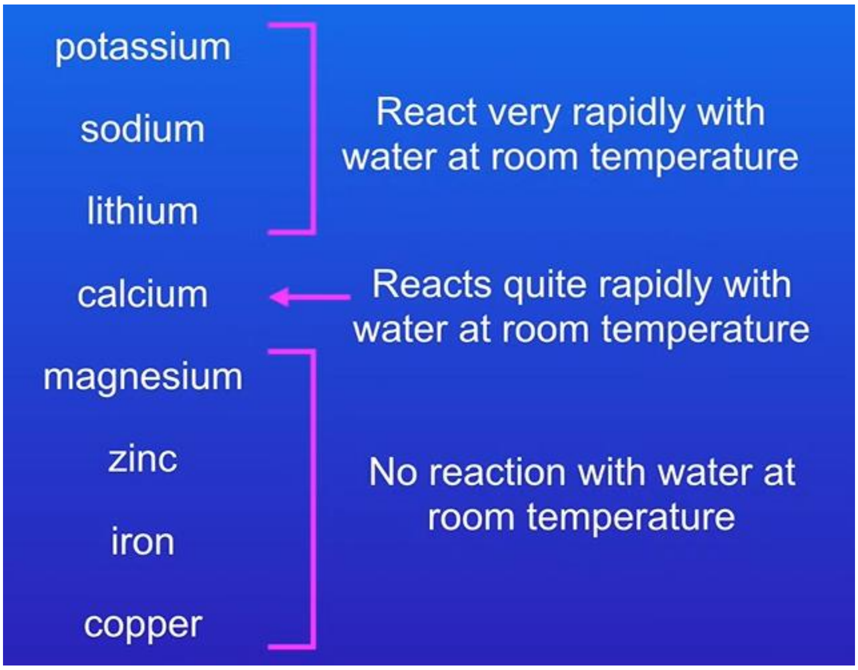
When we gain oxygen in a reaction, the reaction is called an **oxidation** reaction

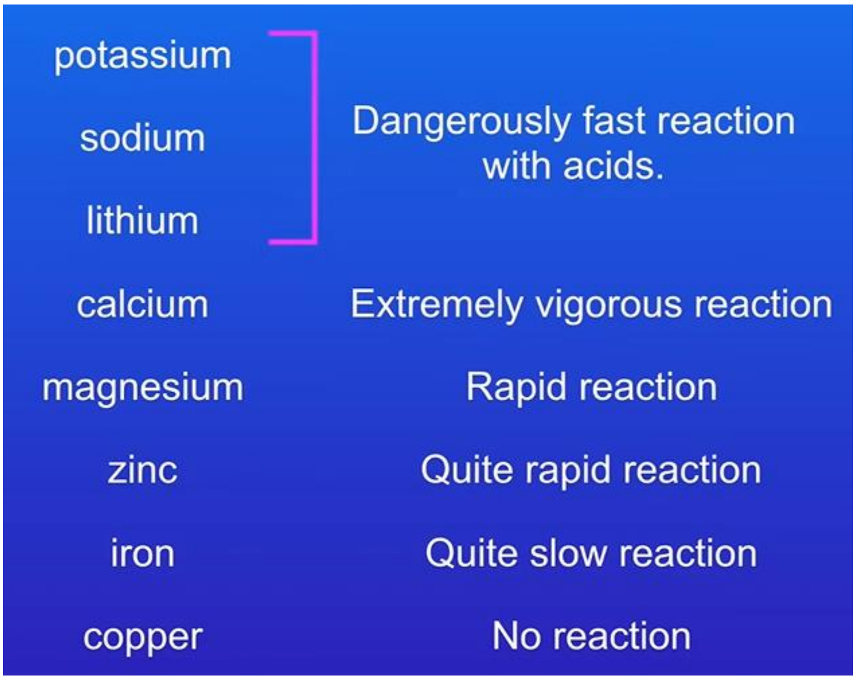
When we lose oxygen in a reaction, the metal has been **reduced**

The reactivity series:

When a metal reacts with water, **metal hydroxide and hydrogen** is produced:




potassium
sodium
lithium
React very rapidly with water at room temperature
calcium
Reacts quite rapidly with water at room temperature
magnesium
zinc
iron
copper
No reaction with water at room temperature


potassium
sodium
lithium
Dangerously fast reaction with acids.
calcium
Extremely vigorous reaction
magnesium
Rapid reaction
zinc
Quite rapid reaction
iron
Quite slow reaction
copper
No reaction

potassium
sodium
lithium
calcium
magnesium
carbon
zinc
iron
hydrogen
copper

Please stop loudly calling me a careless zebra instead try learning how copper saves gold

When metals react, they lose electrons and form positive ions

$$K \longrightarrow K^{+} + e^{-}$$

More reactive metal = More tendency to form positive ion

Less reactive metal = More tendency to form negative ion

<u>Extraction of metals:</u>

Unreactive metals can be found in the earth

A more reactive element will displace a less reactive element from it’s compound

Oxidation and reduction in terms of electrons:

Oxidation is the loss of electrons

Reduction is the gain of electrons

$$Mg \longrightarrow Mg^{2+} + 2e^{-}$$

O I L

R I G

Acid and alkalis:

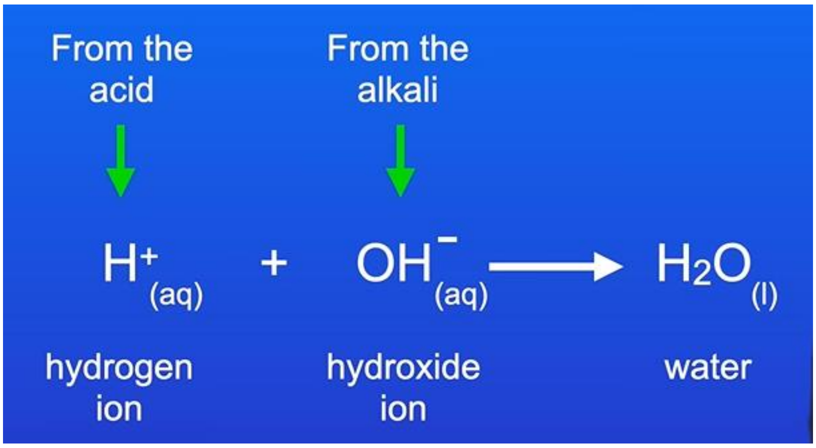
Aqueous solution (aq) means that it is dissolved in water

In aqueous solutions, acids produce hydrogen ions (H^+)

Bases are chemicals which can neutralise acids producing salt and water

Alkalis produce hydroxide ions (OH^-)

Neutralisation reaction: (between acid and alkali)



<u>Acids reacting with metals:</u>

All acids contain hydrogen

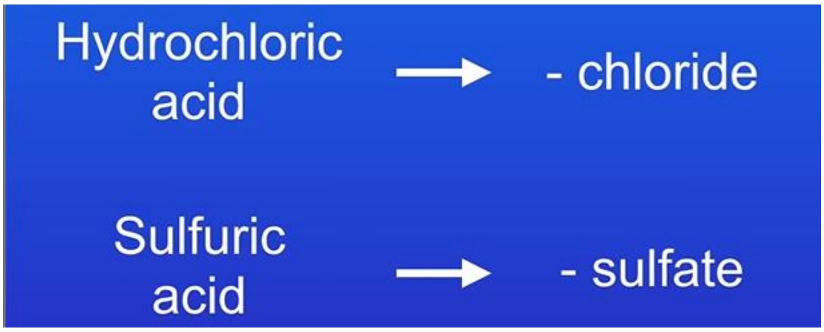
Acid + base > Salt + Water

Acid + metal > Salt + Hydrogen

Acid + carbonate > Salt + Water + Carbon dioxide

Bases can include:

- Metal oxide
- Metal hydroxide



<u>Three reactions with acids:</u>

When we react an acid with a base or an alkali, we make salt and water

Salts contain a positive ion which comes from the base or alkali

Salts contain a negative ion which comes from the acid

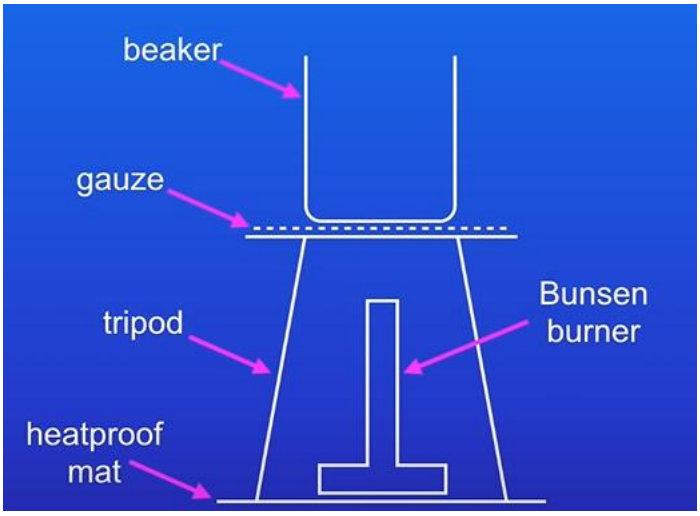
When acids react with a metal carbonates, they make a salt, water and carbon dioxide

Acids can include:

- Sulphuric acid
- Nitric acid
- Hydrochloric acid

Required practical – making soluble salts:

How to perform:



1. Start with a fixed volume of dilute sulfuric acid. This is our limiting reactant (will run out)
2. Gently heat the acid until almost boiling
3. Use a spatula and add small amounts of copper oxide to the acid

4.Stir the solution using a glass rod

5.The copper oxide will react and the colour of the solution will turn blue

6.Continue adding copper oxide if the solution is still blue

7.Stop adding copper oxide if the copper oxide is not reacting

8.The reaction has stopped and all the acid has reacted

9.Use a filter funnel and filter paper to filter the solution into a conical flask to remove the unreacted copper oxide

10.Place the solution in an evaporating basin and heat it over a beaker of boiling water

11.Heat until half the solution remains

12.Leave the solution for 24 hours for copper sulfate crystals to form

13.Scrape crystals onto a paper towel and gently dry them with the tissue

<u>Strong and weak acids:</u>

What is meant by a strong dilute acid:

- Ionises fully in aqueous solution
- Small amount of acid per unit volume

Strong acids fully ionise (split) in aqueous solutions

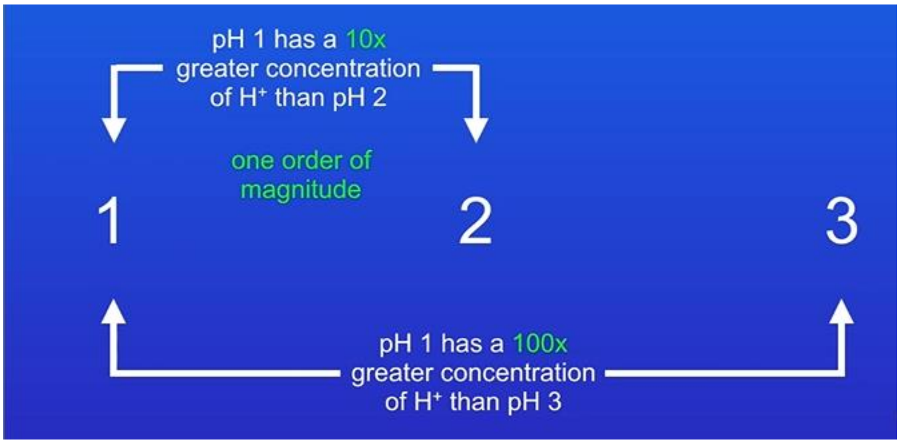
Weak acids partially ionise in aqueous solutions

Weak acids:

- Carbonic acid
- Ethanoic acid
- Citric acid

Strong acids have a lower pH than weak acids. This is because strong acids have a higher concentration of hydrogen ions

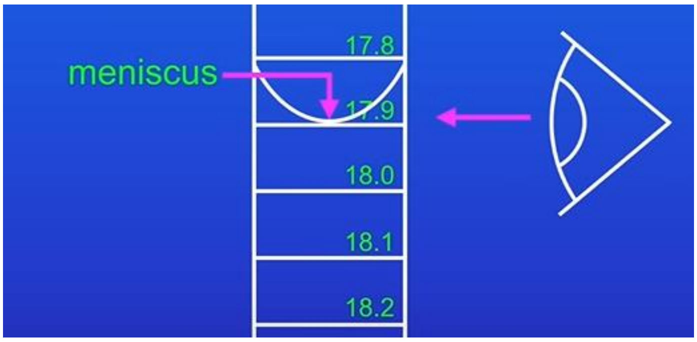
As pH scale decreases by one unit, the concentration of hydrogen ions increases by 10x



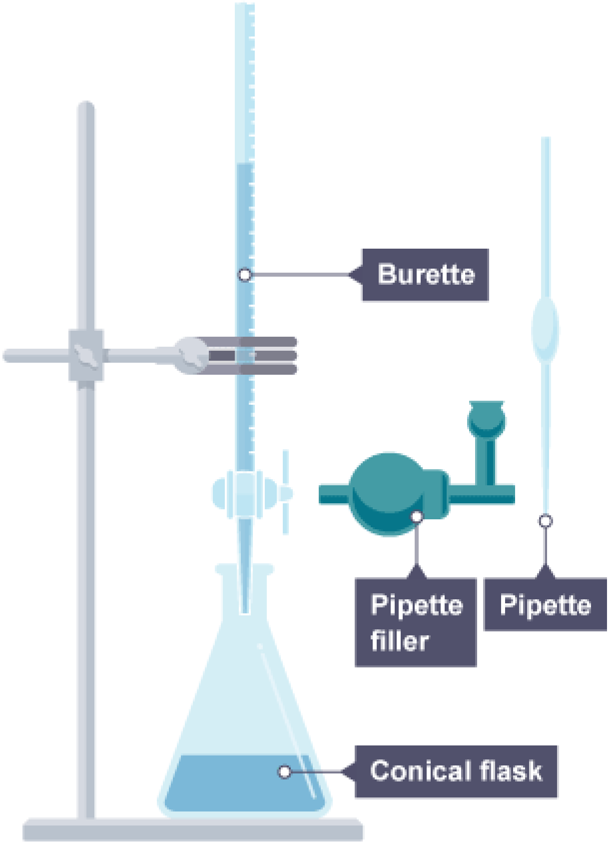
<u>Required practical – Titrations:</u>

How to perform:

1. Use a pipette to transfer 25cm^3 of sodium hydroxide solution into a conical flask
2. Add 5 drops of phenolphthalein indicator into the hydroxide solution
3. Place the conical flask on a white tile so we can see the colour change more clearly
4. Fill a burette with sulfuric acid
5. Place the burette over the conical flask using a clamp
6. Open the tap to add acid to the hydroxide solution
7. Once you see a colour change, keep the tap open slightly to release acid drop by drop
8. Make sure to swirl the solution to make it mix
9. The colour change will go from pink to colourless
10. Read the volume of acid on the burette at the meniscus



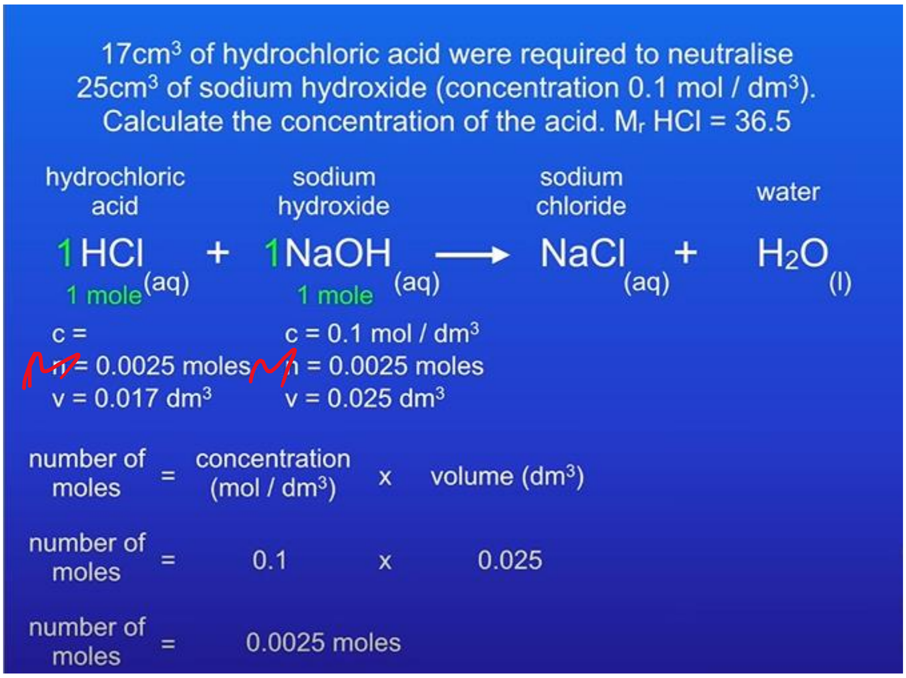
11. We repeat this three more times and and close the tap a bit more quicker and more earlier than this time and calculate the mean volume

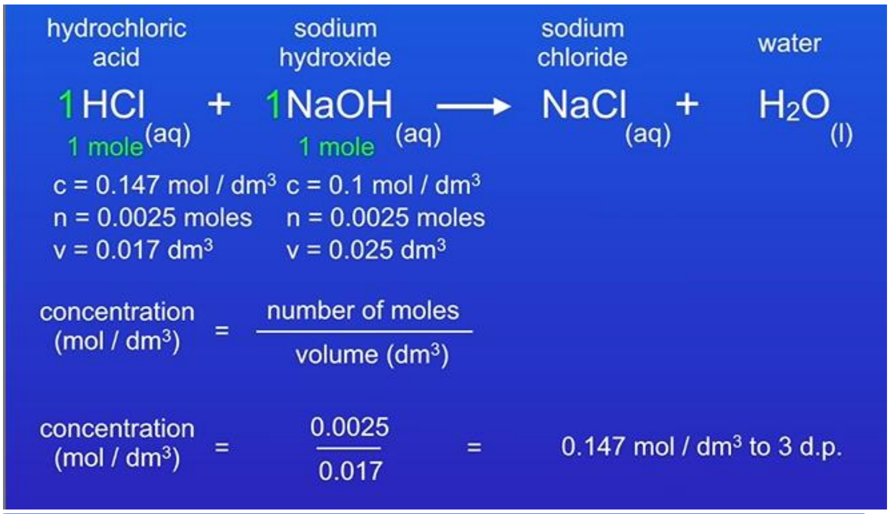


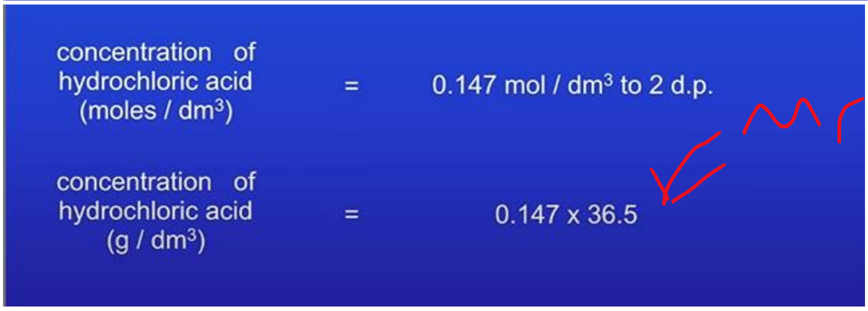
Why is a burette and pipette used:

- Burette because it measures variable volume
- Pipette because it measures a fixed volume accurately

<u>Titration calculations:</u>







<u>Electrolysis:</u>

Solid ionic compounds cannot conduct electricity because they have ions which are not free to move

When an ionic compound is melted or dissolved in water, the forces of attraction are broken and the ions are free to move and carry a charge

In electrolysis, there are two electrodes, the anode (+) and the cathode (-)

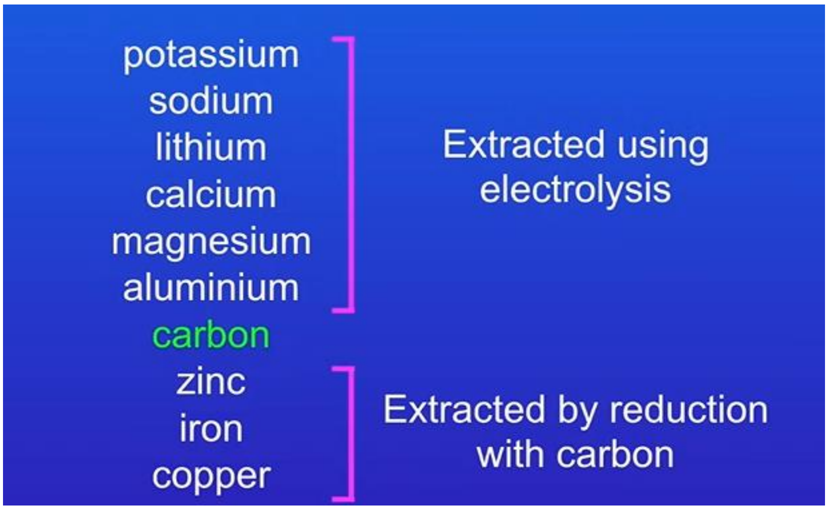
There are electrons at the cathode and lack of electrons at the anode

Reduction (gain of electrons) happens at the cathode and oxidation (loss of electrons) happens at the anode

Remember:

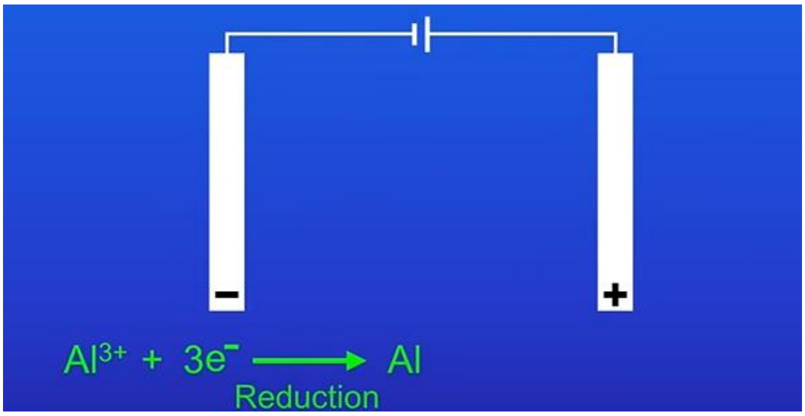
- REDCAT – REDuction at CAThode
- ANOX – ANode OXidation

<u>Electrolysis of Aluminium oxide:</u>

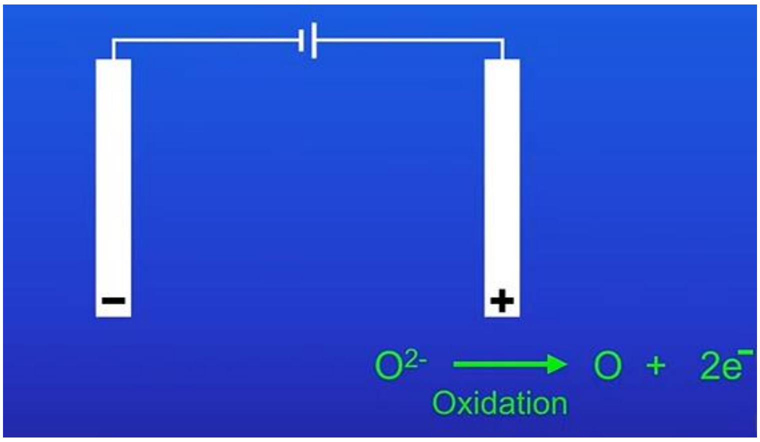


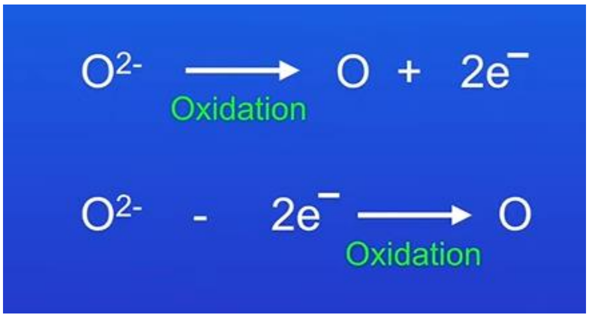
1. Aluminium oxide is mixed with cryolite which lowers the melting point. This reduces the amount of energy needed and saves money

2. The cathode and the anode are both made of graphite (carbon) because it is a very good conductor of electricity and has a very high melting point so it can be used at high temperatures
3. The Al^{3+} ions are attracted to the cathode
4. Reduction happens as it forms an Aluminium atom by gaining 3 electrons

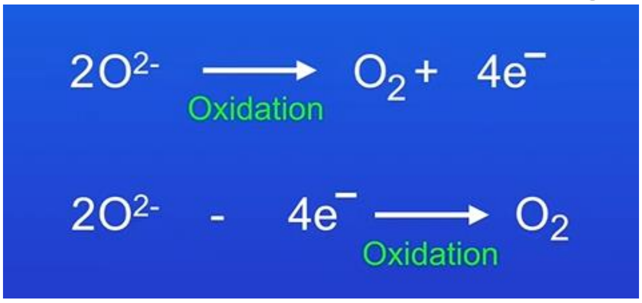


5. O^{2-} is attracted to the anode and loses 2 electrons





These are the same thing



Balanced

The anode must be replaced regularly because the oxygen molecules produced at the anode react with the graphite forming carbon dioxide and overtime this would wear the anode out

Electrolysis is very expensive:

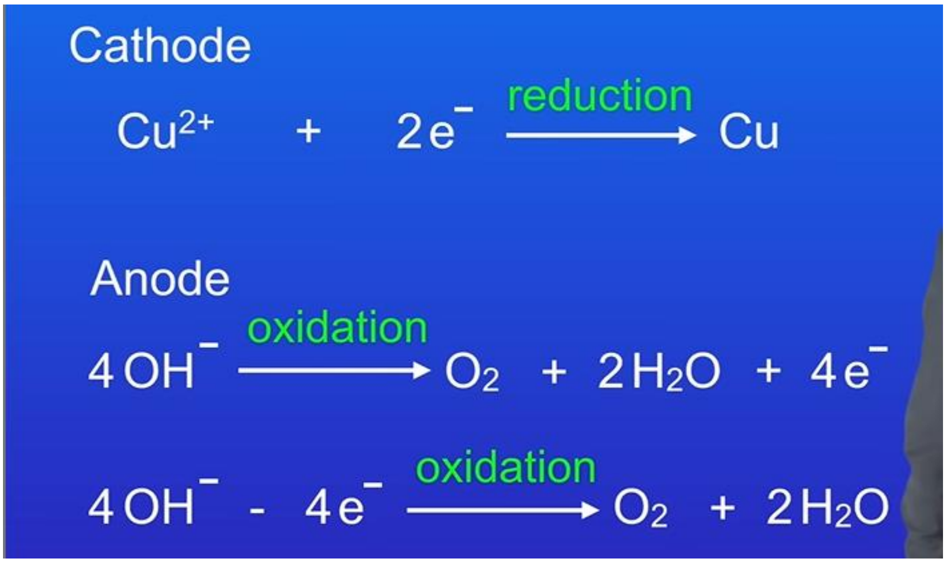
- Melting compounds requires a lot of energy
- A lot of energy is required to produce the electric current

<u>Electrolysis of aqueous solution:</u>

The metal is at the cathode

Hydrogen is produced at the cathode if the metal is more reactive than hydrogen otherwise the metal is produced if it is less reactive than hydrogen

If a halide (halogen) is present it will be produced at the anode, and if carbonate, sulphate or nitrate ions are present, then oxygen is made



The last two equations are the same

Required practical – Electrolysis:

1. First we pour around $50cm^3$ of copper (II) chloride solution into the beaker
2. Place a plastic petri dish over the beaker with two holes
3. We now insert carbon graphite rods into each hole. These are our electrodes
4. We attach crocodile clips to the rods and connect them to a power supply
5. We select 4V and switch it on

- Copper is produced at the cathode as it is less reactive than hydrogen
- Chlorine is produced at the anode because chlorine is a halide ion
- If we hold a blue litmus paper near the anode then it will become bleached because of chlorine

- We can test for hydrogen with the lit splint producing a squeaky pop

Note: Make sure the electrodes are not touching each other otherwise there will be a short circuit

Test	Observation	Inference
Glowing splint held in a test tube	Splint relights	Oxygen is present
Lighted splint held in a test tube	Pop sound heard	Hydrogen is present
Gas bubbled through limewater	Limewater turns milky or cloudy white	Carbon dioxide is present
Damp litmus paper held in a test tube	Paper turns white	Chlorine is present