5.4- Chemical Changes and Electrolysis

Displacement reactions

*A more **reactive metal** will **displace** a less **reactive metal** from a compound.*

Extracting metals

*Most **metals** are found as **metal compounds** in rocks known as **ores**.*

- These metals must be **extracted** by **chemical reactions**.
- Most metals have combined with **Oxygen** in a process called **oxidation.**
- Metals LESS **reactive** than **carbon** can be **extracted** from their oxides by **reduction** with **Carbon**.
- Metals MORE **reactive** than **Carbon** can be **extracted** from their **oxides** by **reduction** with **hydrogen** or by **electrolysis**.
- Some **metals** are so **unreactive** they are found in their **native state (**e.g. Gold)

Salts from metals

Reactions between **acids** and **metals** can only happen if the **metal** is more **reactive** than the **Hydrogen** in the **acid.** When a **reaction** does take place a **salt** is formed.

- **Acid** + **Metal** -> **Salt** + **Hydrogen**
- **Acid** + **Alkali** -> **Salt** + **Water**
- **Acid** + **Metal Oxide** -> **Salt** + **Water**
- **Acid** + **Metal Carbonate** -> **Salt** + **Water** + **Carbon Dioxide**
- **Hydrochloric acid** makes **metal chlorides**
- **Sulphuric** acid makes **metal sulphates**
- **Nitric** acid makes **metal nitrates**

Crystals of a salt can be obtained from a solution by crystallisation.

Salts from insoluble bases

Bases** are compounds that can **neutralise acids.

When you **react** an **acid** with a **base**, a salt and **water** are formed. **Salts** are made up of **positive metal ions** and a **negative ion** from an **acid**. The **positive ions** come from a **metal, base** or **carbonate**.

The Reactivity Series

*A list of metals in order of **reactivity**. The most **reactive metals** are at the top and the least **reactive** are at the bottom.*

*The greater the tendency of a **metal atom** to lose its **outer shell electron**(s) the more **reactive** the **metal.***

Order of reactivity	Reaction with water	Reaction with dilute acid
potassium	fizz, giving off hydrogen gas, leaving an alkaline solution of metal hydroxide	explode
sodium		
lithium		
calcium		fizz, giving off hydrogen gas and forming a salt
magnesium	very slow reaction	
aluminium		
zinc		
iron		
tin	slight reaction with steam	react slowly with warm acid
lead		
copper	no reaction, even with steam	no reaction
silver		
gold		

Ionic Equations for Displacement reactions

*Shows the **atoms** and **ions** that change in a **reaction**.*

Magnesium + Copper (II) sulfate -> Magnesium sulfate + Copper

$Mg(s) + CuSO_4(aq) \rightarrow MgSO_4(aq) + Cu(s)$

In the above reaction the sulfate ions, SO_4^{2-} (aq), remain the same so do not appear in the equation.

$Mg(s) + Cu^{2+}(aq) \rightarrow Mg^{2+}(aq) + Cu(s)$

Required Practical: Making a Copper salt

You can make **Copper Sulfate** crystals from **Copper Oxide** (an **insoluble base**) and **Sulphuric Acid**.

1. Add **Copper Oxide** to **Sulfuric Acid** and stir whilst warming gently on a tripod and gauze.

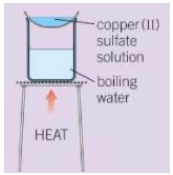
2. As the reaction occurs observe the solution turning blue as **Copper Sulfate** is formed.

Excess black **Copper Oxide** will also be seen.

3. When the **reaction** is complete **filter** the solution to remove the excess **Copper Oxide**.

4. Start to **evaporate** the water so that **crystals** start to form. As soon as they do remove from the heat and let the rest of the water **evaporate** slowly. This will form larger **crystals.**

The equation for the reaction is:



Sulfuric Acid + **Copper**(II) **Oxide** —> **Copper**(II) **Sulfate** + **Water**

$H_2SO_4(aq) + CuO(s) \rightarrow CuSO_4(aq) + H_2O(l)$

Safety:

Wear eye protection and do not boil the acid, only warm it gently!

Oxidation is LOSS of electrons, Reduction is GAIN of electrons. Remember OILRIG

Making more salts

*There are two other reactions that can be used to make **salts**.*

- Reacting **solutions** of an **acid** and **alkali** together

  Acid + **Alkali** -> a **Salt** and **Water**

- Reacting an acid with a **Carbonate** (usually a solid)

Acid + a **Carbonate** -> a **Salt** + **Water** + **Carbon Dioxide**

Electrolysis

Electrolysis** means breaking down with **electricity.

- ***Electrolyte:** A liquid or **solution** that **conducts electricity***

- ***Electrode:** A solid that is put into the **electrolyte** that **conducts electricity.***

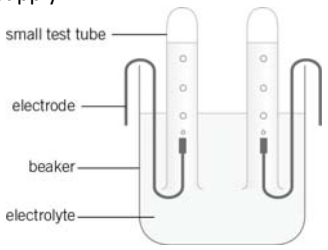
- In **electrolysis** a current is passed through the **electrolyte**. The **ions** move towards the **electrodes** where they react and the **compound** is broken down.

- **Positive ions** move towards the **cathode** (-ve electrode) and gain electrons **(reduction).**

- **Negative ions** move towards the **anode** (+ve electrode) and lose electrons **(oxidation).**

Required Practical: Investigating the electrolysis of a solution

1. Half fill a beaker with the **solution** to be **electrolysed**.
2. Submerge the ends of the two **electrodes**, and use crocodile clips and wires connect them to the low voltage power supply.
3. Make sure that the **electrodes** are not touching.
4. Turn on the power supply and observe. If you see bubbles, a gas is being made. Turn off the power supply.
5. Wearing nitrile gloves, fill three ignition tubes with the **solution**. Hold them upright so that the opening is still under the liquid level and over the electrode that is making the gas.
6. Turn on the power and when the ignition tube is full of gas, seal it with a bung.
7. Repeat steps 5 and 6 until three ignition tubes have been collected from each electrode that is making a gas.
8. Turn off the power supply.



Test each gas:

Oxygen = Re-light a glowing splint

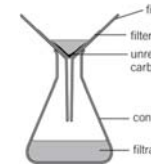
Hydrogen = Squeaky pop

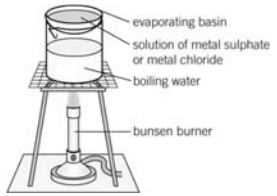
Chlorine = Litmus paper turns red and bleaches.

Required Practical: Making a salt from a metal carbonate

Soluble salts can be made from acids by reacting them with solid insoluble substances .

1. Measure 20cm³ of Sulfuric Acid into a beaker.
2. Add half a spatula of metal carbonate and stir with a glass rod.
3. Keep adding the metal Carbonate until no more dissolves and there is no more fizzing.
4. Filter the mixture and discard the unreacted metal carbonate.
5. Pour the filtrate into an evaporating basin and place it on a beaker of water (water bath) .
6. Heat the water gently until the volume of the solution in the evaporating dish is halved.
7. Remove from heat and leave overnight to crystallise.
8. Remove the crystals from the solution with a spatula and gently pat them dry between two pieces of filter paper .





Neutralisation and the pH scale

The **pH scale** measures the **acidity** or **alkalinity** of a **solution**, using either **universal indicator** or individual **pH indicators** or using an **electronic pH meter**.

- All **acids** produce **hydrogen ions** in **aqueous solution**, the excess **ions** makes the **solution acidic.**

Alkalis produce **hydroxide ions** in **aqueous solutions** , the excess **ions** make a **solution alkaline.**

Examples of strong acids	Examples of weak acids
hydrochloric acid	ethanoic acid (found in vinegar)
nitric acid	citric acid (found in citrus fruits)
sulfuric acid	carbonic acid (found in rainwater, fizzy drinks)

Neutralisation reactions happen when **hydrogen ions** from the **acid** react with **hydroxide ions** to produce water.

Equation for Neutralisation.

$H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O$