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Chemistry Topic 4
Chemical Changes - FOUNDATION

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Section 1: Key Terms

Displacement reaction	A **more reactive metal** will **displace** a **less reactive metal** from a **compound**. e.g. Iron is more reactive than copper and so will displace copper from solution. $Fe(s) + CuSO_4(aq) \rightarrow FeSO_4(aq) + Cu(s)$
Oxidation	Definitions: Chemicals are oxidised if they **gain oxygen** in a reaction.
Reduction	Definitions: Chemicals are oxidised if they **lose oxygen** in a reaction.
Acid	A chemical that **dissolves in water** to produce **H^+ ions**. Acids are proton donors
Base	A solid with a pH from 8-14 that **reacts with acids** and **neutralise** them. E.g. **metal oxides**, **metal hydroxides**, **metal carbonate**
Alkali	A solution with a pH from 8-14 (soluble **base**) that produces **OH- ions** in solution.
Neutralisation	When a **neutral solution** is formed from reacting an **acid** and **alkali**. Ionic equation: $\mathbf{H^+ + OH^- \rightarrow H_2O}$
pH	A scale to **measure acidity/ alkalinity**.

Section 2: The Reactivity Series

Metals can be placed in order of reactivity by their reactions with water and dilute acid. Hydrogen gas is given off when metals react with acid or water. The gas gives a squeaky pop with a lighted spill.

Element	Reaction with water	Reaction with acid	Reactivity
Potassium (Please)	Potassium **melts**, floats & moves around very quickly. It **sets on fire** with a **lilac flame**. Alkaline solution forms.	Explodes	
Sodium (Stop)	Sodium **melts** to form a ball that moves around on the surface. It **fizzes rapidly**. Alkaline solution forms.	Explodes	
Lithium	Lithium floats. It **fizzes steadily** and becomes smaller. Alkaline solution formed.	Explodes	
Calcium (Calling)	It fizzes steadily leaving an alkaline solution.	**Fizzes quickly** with dilute **acid**.	
Magnesium (My)	Very slow reaction	**Fizzes quickly** with dilute **acid**.	
(Carbon)			
Zinc (Zebra)	Very slow reaction	**Bubbles slowly** with dilute **acid**.	
Iron (In)	Very slow reaction	**Very slow reaction** with dilute **acid**.	
(Hydrogen)			
Copper (Class)	No reaction	No reaction	
Silver (She)	No reaction	No reaction	
Gold (Grunts)	No reaction	No reaction	

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Chemistry Topic 4
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Section 3: Extracting Metals

Very unreactive metals e.g. Silver and gold	Found **naturally** in the ground (native). Extracted using **mining**.
Metals **less reactive than carbon** e.g. Zinc, Iron & Lead	Metals less reactive than carbon can be extracted from their ores by **reduction** using **carbon**, coke or charcoal. $2PbO_{(s)} + C_{(s)} \rightarrow 2Pb_{(s)} + CO_{2(g)}$ Carbon has **displaced** lead from its oxide because carbon is more reactive than lead. This extraction takes place in a **blast furnace** at high temperature.
Metals **less reactive than hydrogen** e.g. Tungsten	Metals less reactive than hydrogen can be extracted from their ores by **reduction** using hydrogen. Tungsten is obtained from its oxide by reduction using hydrogen. $WO_{3(s)} + 3H_{2(g)} \rightarrow W_{(s)} + 3H_2O_{(g)}$
Metals more reactive than carbon e.g. Aluminium	Extracted by **electrolysis**.

Section 4a: Salts from metals (neutralisation reactions)

With metal	Acid + Metal → Salt + Hydrogen $2HCl_{(aq)} + Fe_{(s)} \rightarrow FeCl_{2(aq)} + H_{2(g)}$
With alkali	Acid + Metal Hydroxide → Salt + Water $HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$
With metal oxide	Acid + Metal Oxide → Salt + Water $2HCl_{(aq)} + MgO_{(s)} \rightarrow MgCl_{2(aq)} + H_2O_{(l)}$
With metal carbonate	Acid + Metal Carbonate → Salt + Water + Carbon Dioxide $2HCl_{(aq)} + CaCO_{3(s)} \rightarrow CaCl_{2(aq)} + H_2O_{(l)} + CO_{2(g)}$

Section 4b: Making a Soluble Salt

A salt is a compound formed when the hydrogen in an acid is wholly, or partially, replaced by metal or ammonium ions.

Salts are made when a suitable metal, metal carbonate, metal oxide or metal hydroxide is reacted with acid.

Crystallisation

Pure dry crystals can be obtained from solution by:

- Heat acid gently to speed up the rate of reaction.
- **Add solid** metal, metal carbonate, metal oxide or metal hydroxide **to an acid**.
- Add solid in excess **until no more reacts** (saturated solution).
- **Filter** off excess solid using funnel and filter paper.
- **Evaporate** to remove some of the water using a **water bath**.
- Leave to **crystallise** and dry overnight.
- Wash and dry crystals **in air**/in a **desiccator/oven**.

Evaporation

When you react an acid with an alkali, you need to be able to tell when the acid and alkali **have completely reacted**.
Then you can collect pure dry crystals of the salt.

- Add **acid** to beaker and add **universal indicator**.
- Add alkali until the universal indicator turns **green**.
- Add activated charcoal to remove the colour and **filter**.
- Pour solution into evaporating basin
- Heat
- **Leave to crystallise** / boil off water

Acidic pH 0-6 Neutral pH 8-14 Alkaline

pH	1	2	3	4	5	6	7	8	9	10	11	12	13	14

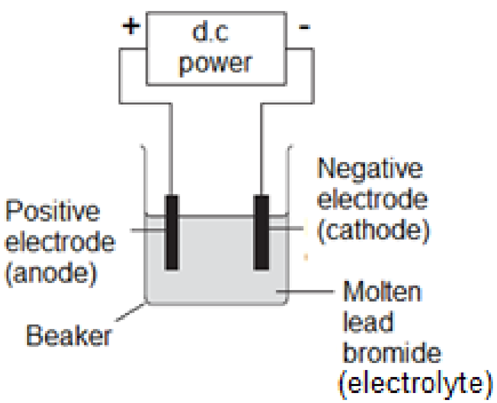
Section 5: Indicators

Measuring acidity or alkalinity
Indicators = Substances that change colour when you add an acid or an alkali.
Litmus = Indicator that turns red in acid and blue in alkali.
pH meter = Gives a digital reading of pH, which is more accurate.

KNOWLEDGE — Chemistry Topic 4 Electrolysis — ORGANISER

Section 1 Electrolysis key terms

Electrolysis	The process of **splitting an ionic compound** by passing **electricity** through it.
Electrolyte	An **ionic compound** that is **molten** (melted) or **dissolved in water**. The electrolyte is broken down by electricity enabling its **ions** to **move freely** and carry a charge.
Electrode	An **electrical conductor** that is placed in the **electrolyte** and connected to the **power supply**.
Cathode	The **negative electrode**. The electrode attached to the negative terminal of the power supply.
Anode	The **positive electrode**. The electrode attached to the positive terminal of the power supply.



Positive
Anode
Negative
Is
Cathode

Section 2a: Changes at the electrodes – Pure ionic compounds

Electrolyte	Cathode	Anode
Molten Compound $_{(l)}$	Metal	Non-metal produced.
Molten lead bromide (diagram above)	**Lead metal** is produced	**Bromine** is produced

Section 2b: Changes at the electrodes – Aqueous solutions

Electrolyte	Cathode	Anode
Dissolved compound $_{(aq)}$ - aqueous solution/ dissolved in water	The **less reactive** one from **metal and hydrogen** is made.	• If the **solution contains halide ions** (chloride, bromide, iodide), the **<u>halogen</u>** (chlorine, bromine, iodine) is produced. • If there are no halide ions, **<u>oxygen</u>** is produced.

Electrolyte	Cathode	Anode
$CuBr_{2(aq)}$	Copper	Bromine
$NaCl_{(aq)}$	Hydrogen	Chlorine
$KI_{(aq)}$	Hydrogen	Iodine
$Na_2SO_{4(aq)}$	Hydrogen	Oxygen

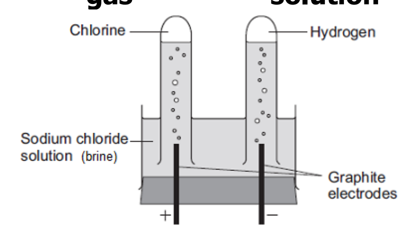
Electrolysis of Brine (concentrated sodium chloride solution)

In the electrolysis of brine, **three products** are formed, **hydrogen, chlorine** and **sodium hydroxide.**

Sodium chloride solution → hydrogen gas + chlorine gas + sodium hydroxide solution

At the negative **cathode, Hydrogen** gas forms.

At the positive **anode, Chlorine** gas forms.



Sodium ions stay in solution (as sodium is more reactive than hydrogen) and **combine with hydroxide ions** to form sodium hydroxide.

$Na^+ + OH^- \rightarrow NaOH$

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Chemistry Topic 4 Electrolysis

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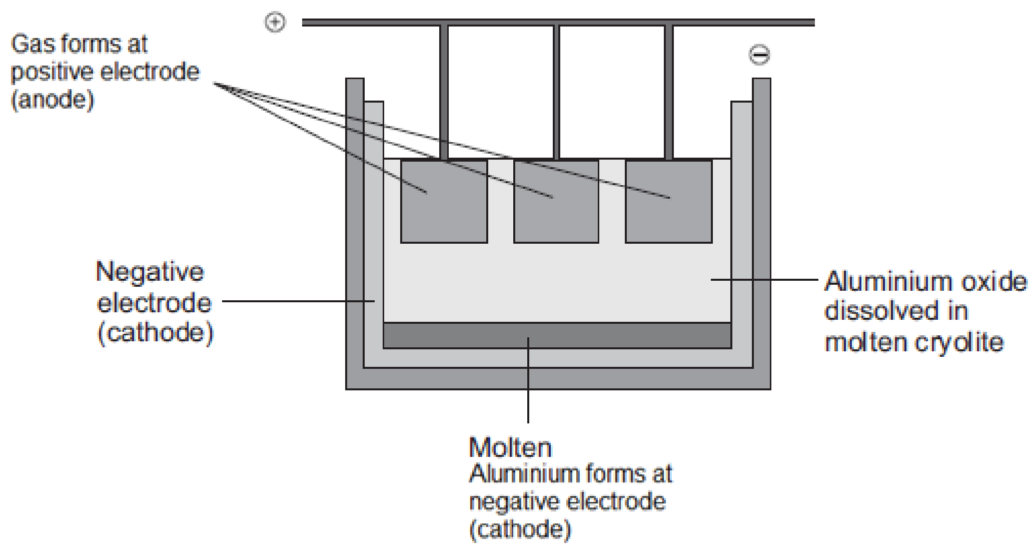
Section 3a: The extraction of Aluminium by electrolysis	
Bauxite	You get aluminium oxide from the ore (rock) called **Bauxite.** The ore is mined by **open cast mining**.
Cryolite	**Aluminium oxide** is **dissolved in <u>molten cryolite</u>** to **lower its melting point**. This **saves money on energy costs**.
Graphite	The **electrodes** are made from **graphite** (carbon) because graphite can conduct electricity (as it has delocalised electrons between it's layers.)
Cathode	Positive Al^{3+} **ions move to the cathode**. Aluminium is produced. $\mathbf{Al^{3+} + 3e^- \rightarrow Al}$
Anode	Negative O^{2-} **ions move to the anode**. Oxygen is made. $\mathbf{2O^{2-} \rightarrow O_2 + 4e^-}$ The anode **wears away** gradually as the **carbon graphite anode reacts with oxygen** to form **carbon dioxide gas**.



Section 3b: Uses of Aluminium

Aluminium is a very important metal, the uses of its metal or alloys include:

- Pans
- Overhead power cables
- Aeroplanes
- Cooking foil
- Drink cans
- Window and patio door frames
- Bicycle frames and car bodies