

KNOWLEDGE



Chemistry Topic 5 Chemical changes

ORGANISER

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 hence will displace copper from solution. $\text{Fe(s)} + \text{CuSO}_4\text{(aq)} \rightarrow \text{FeSO}_4\text{(aq)} + \text{Cu(s)}$
Oxidation	Two definitions: Chemicals are oxidised if they gain oxygen in a reaction. Chemicals are oxidised if they lose electrons in a reaction. (HT)
Reduction	Two definitions: Chemicals are oxidised if they lose oxygen in a reaction. Chemicals are oxidised if they gain electrons in a reaction. (HT)
Acid	A chemical that dissolves in water to produce H⁺ ions . Acids are proton donors
Base	A chemical that reacts with acids and neutralise them. E.g. metal oxides, metal hydroxides, metal carbonate
Alkali	A soluble base that produces OH⁻ ions in solution.
Neutralisation	When a neutral solution is formed from reacting an acid and alkali . Ionic equation: $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$
pH	A scale to measure acidity/ alkalinity . A decrease of one pH unit causes a 10x increase in concentration of H⁺ ions . (HT)
Strong acid (HT)	Strong acids completely ionise in solution. E.g. hydrochloric, nitric and sulfuric acids.
Weak acid (HT)	A weak acid is only partially ionised in solution. E.g. ethanoic, citric and carbonic acids.

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	Potassium melts , floats & moves around very quickly. It sets on fire with a lilac flame . Alkaline solution forms.	Explodes	↑
Sodium	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	It fizzes steadily leaving an alkaline solution.	Fizzes quickly with dilute acid .	
Magnesium	Very slow reaction	Fizzes quickly with dilute acid .	
(Carbon)			
Zinc	Very slow reaction	Bubbles slowly with dilute acid .	
Iron	Very slow reaction	Very slow reaction with dilute acid .	
(Hydrogen)			
Copper	No reaction	No reaction	
Silver	No reaction	No reaction	
Gold	No reaction	No reaction	

KNOWLEDGE



Chemistry Topic 5 Chemical changes

ORGANISER

Section 3: Extracting Metals

Very unreactive metals e.g. Silver and gold	Found naturally in the ground. 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. $2\text{PbO(s)} + \text{C(s)} \rightarrow 2\text{Pb(s)} + \text{CO}_2\text{(g)}$ 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. $\text{WO}_3\text{(s)} + 3\text{H}_2\text{(g)} \rightarrow \text{W(s)} + 3\text{H}_2\text{O(g)}$
Metals more reactive than carbon e.g. Aluminium	Extracted by electrolysis .

Section 4a: Salts from metals (neutralisation reactions)

With metal	Acid + Metal \rightarrow Salt + Hydrogen $2\text{HCl(aq)} + \text{Fe(s)} \rightarrow \text{FeCl}_2\text{(aq)} + \text{H}_2\text{(g)}$
With alkali	Acid + Metal Hydroxide \rightarrow Salt + Water $\text{HCl(aq)} + \text{NaOH(aq)} \rightarrow \text{NaCl(aq)} + \text{H}_2\text{O(l)}$
With metal oxide	Acid + Metal Oxide \rightarrow Salt + Water $2\text{HCl(aq)} + \text{MgO(s)} \rightarrow \text{MgCl}_2\text{(aq)} + \text{H}_2\text{O(l)}$
With carbonate	Acid + Metal Carbonate \rightarrow Salt + Water + Carbon Dioxide $2\text{HCl(aq)} + \text{CaCO}_3\text{(s)} \rightarrow \text{CaCl}_2\text{(aq)} + \text{H}_2\text{O(l)} + \text{CO}_2\text{(g)}$

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:

- **Add solid** metal, metal carbonate, metal oxide or metal hydroxide **to an acid**.
- Add solid **until no more reacts** (saturated solution).
- **Filter** off excess solid.
- **Evaporate** to remove some of the water.
- Leave to **crystallise**.
- Filter the crystals
- Leave to dry **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.

- Carry out an **acid/alkali titration** using an indicator to see how much acid **reacts completely** with alkali
- **Run that volume of acid again** into solution of alkali but **without indicator**.
- Pour solution into evaporating basin
- Heat
- **Leave to crystallise** / boil off water

Section 5: Strong and weak acids

Aqueous solutions of **weak acids have higher pH** than solutions of **strong acids with the same concentration**. Strong acids **completely ionise** in solution to produce hydrogen ions. e.g. $\text{HCl(aq)} \rightarrow \text{H}^+\text{(aq)} + \text{Cl}^-\text{(aq)}$

Weak acids **only partially ionise** in solution. The reaction is **reversible** (unlike the ionisation of strong acids.) So as the molecules of the weak acid split up to form its ions, the ions recombine to form the original molecule.

e.g. Ethanoic acid: $\text{CH}_3\text{COOH(aq)} \rightleftharpoons \text{CH}_3\text{COO}^-\text{(aq)} + \text{H}^+\text{(aq)}$

A position of **equilibrium** is reached in which both the original molecule (majority) and its ions (minority) are present.

Measuring acidity or alkalinity

Indicators are substances that change colour when you add an acid or an alkali. Litmus is an indicator that turns red in acid and blue in alkali. You can also use a pH meter which gives a digital reading of pH.

