Lesmahagow High School

National 5 Chemistry: Unit 1

Key Area – Acids and Bases

Learning Statement	Red	Amber	Green

The pH scale is a continuous range of numbers.

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
← Acids →							Neutral	← Bases →						

- it is possible to get values below 0 and above 14.

pH **below** 7	pH **equal to** 7	pH **above** 7
Acid	Neutral (including pure water)	Base

An alkali is a soluble base.

Examples of common household and laboratory acids and alkalis.

Acids		**Alkalis**	
Household	**Laboratory**	**Household**	**Laboratory**
Vinegar	Sulfuric acid	Baking soda	Sodium hydroxide
Lemon juice	Hydrochloric acid	Caustic soda	Ammonia solution
Fizzy drinks	Nitric acid	Oven cleaner	Potassium hydroxide

Examples of bases include metal oxides, metal carbonates or metal hydroxides.

Making Acids

- Non-metal oxides dissolve in water to produce acidic solutions.
  - carbon dioxide + water → carbonic acid
  - sulfur dioxide + water → sulfurous acid
  - nitrogen dioxide + water → nitrous acid

Problems with Acids

Sulfur dioxide reacts with water in the atmosphere to produce **acid rain**.

The damaging effects of acid rain include:

- damage to building rocks
- damage to structures like metal bridges
- acidifying soil which reduces crop growth
- damage to the habitat of plant and animal life.

Making Alkalis

Alkalis are soluble bases that are made by dissolving metal oxides or metal hydroxides in water.

e.g. lithium oxide, sodium oxide, potassium oxide or magnesium oxide.

e.g. potassium hydroxide, sodium hydroxide or calcium hydroxide.

Acids and alkalis contain ions.

- Acids contain the hydrogen ion, **$H^+(aq)$**
- Alkalis contain the hydroxide ion, **$OH^-(aq)$**

This means that solutions of acids and alkalis can conduct electricity.

Acidic and alkaline solutions contain the following ions:

Type	Ion(s) Present	Numbers of Ions
Acid	$H^+(aq)$ and $OH^-(aq)$	$H^+(aq) > OH^-(aq)$
Neutral	$H^+(aq)$ and $OH^-(aq)$	$H^+(aq) = OH^-(aq)$
Alkali	$H^+(aq)$ and $OH^-(aq)$	$H^+(aq) < OH^-(aq)$

Diluting solutions of acids or alkalis has the following effects.

Type of Solution	Effect of Dilution on pH	Effect of Dilution on Solution	Effect of Dilution on Ions
Acid	0 → 7	Acidity decreases	Decrease in the concentration of $H^+(aq)$ ions
Neutral	7 → 7	No change	No change in the concentration of $H^+(aq)$ or $OH^-(aq)$ ions. **$H^+(aq) = OH^-(aq)$**
Alkali	14 → 7	Alkalinity decreases.	Decrease in the concentration of $OH^-(aq)$ ions

When an acid reacts with a base a reaction called **neutralisation** occurs.

Neutralisation changes the pH of acids and bases.

Type of Substance	Effect on pH	Example of pH Change
Acid	Increases to 7	pH = 0 → pH = 7
Base	Decreases to 7	pH = 14 → pH =7

There are many everyday examples of neutralisation reactions.

- Reducing soil acidity by adding lime.
- The use of lime to reduce acidity in lakes caused by acid rain.
- Treatment of indigestion.
- Treating wasp or bee stings.

In neutralisation the hydrogen ions in acids react with the hydroxide ions found in alkalis to form water.

$$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$$

hydrogen ion + hydroxide ion → water

In reactions involving metal carbonates, carbon dioxide gas is also formed.

$$2H^+(aq) + CO_3^{2-}(aq) \rightarrow CO_2(g) + H_2O(l)$$

hydrogen ions + carbonate ion → carbon dioxide + water

Acids react with bases and metals to form salts.

acid	+	alkali (metal hydroxide)	→	salt	+	water		
acid	+	metal oxide	→	salt	+	water		
acid	+	metal carbonate	→	salt	+	water	+	carbon dioxide
acid	+	metal	→	salt	+	hydrogen		

The chemical test for hydrogen gas is that it ignites with a squeaky pop.

The chemical test for carbon dioxide is that it turns lime water chalky.

A salt is a substance in which the hydrogen ion of an acid has been replaced by a metal ion.

- Ammonium ions (NH_4^+) can also replace hydrogen ions (H^+) to make salts.
- Most ionic substances are salts (except oxides and hydroxides).

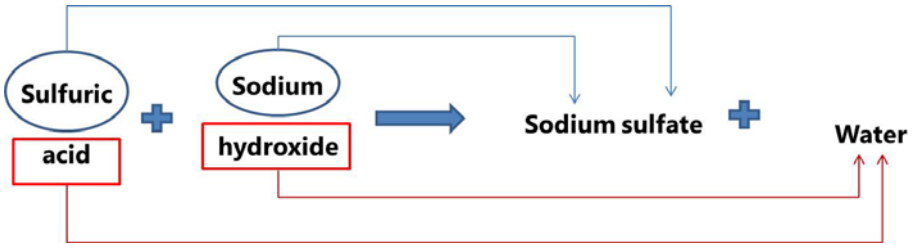
To name the salt formed in reactions, we have to use the name of the acid and base.

- The neutraliser provides the first name of the salt formed.

Neutraliser Name	Sodium hydroxide	Potassium oxide	Calcium Carbonate
First Name of Salt	Sodium	Potassium	Calcium

- The acid provides the second name of the salt formed.

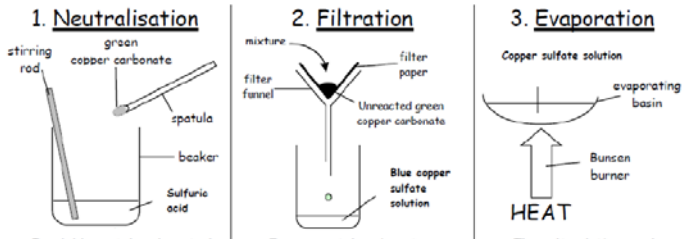
Acid Name	Hydrochloric acid	Sulfuric acid	Nitric acid
Second Name of Salt	…chloride	…sulfate	…nitrate



There are 2 types of salt: **soluble** and **insoluble**.

Making Soluble Salts

Soluble salts are made by **(1) Neutralisation, (2) Filtration and (3) Evaporation.**



1. Insoluble metal carbonate (or metal oxide) is used to neutralise the acid.
2. When all acid has been neutralised, some excess carbonate or oxide will lie on the bottom of the beaker

2. Excess metal carbonate (or metal oxide) is removed from the solution by fitration
3. The *residue* in the filter paper is unreacted metal carbonate
4. The filtrate in beaker is the solution of salt you are making

3. The salt solution can be returned to the solid salt by evaporating the water

NB: If the metal carbonate or metal oxide used is soluble
- the excess metal carbonate/metal oxide would dissolve in the water
- filtration would not remove the excess metal carbonate/metal oxide
- salt you are making would be contaminated by the reactants

Making Insoluble Salts

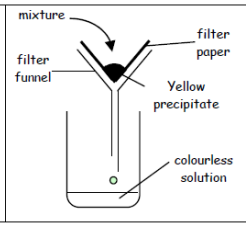
Insoluble salts are made by a **precipitation** reaction. This involves mixing two solutions and forming a powdery solid called a precipitate.

****The precipitate is the insoluble salt****

When 2 solutions are mixed, there can be a chemical reaction where one of the products is insoluble in water.

- Insoluble solid product of chemical reaction is called a *precipitate*
- Insoluble salts can be *formed* by **precipitation** and *collected* by **filtration**

potassium iodide (colourless solution) + lead nitrate (colourless solution) → lead iodide (yellow insoluble solid) + potassium nitrate (colourless solution)



The insoluble solid formed in a precipitation reaction can be identified by:

Writing down the names of the reactants			Swap the names over		Check p5 of data book for solubility of products	
Potassium Iodide		Lead Nitrate	Potassium Nitrate	Lead Iodide	Potassium Nitrate is soluble ↓ Dissolved in solution	Lead Iodide is insoluble ↓ Precipitate on bottom

A special technique can be carried out to accurately work out how much base is needed to neutralise an acid. This technique is called a **titration**.

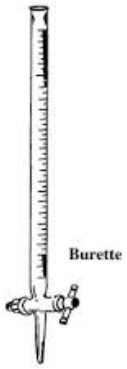
Titration experiments involve using the following apparatus:

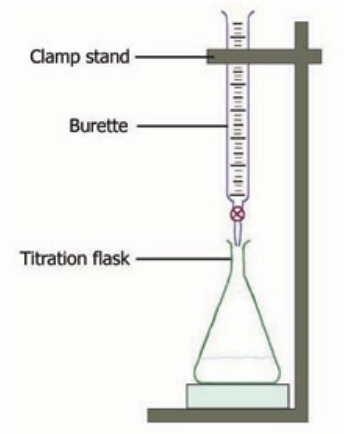
1. **A Pipette**

   A pipette is used to accurately measure out a volume of solution into a conical flask.

2. **A Burette**

   A burette is a graduated piece of glassware with a tap at the bottom of it. It can be used to release small volumes of a solution into a conical flask. Using small volumes of solution, sometimes drop by drop, allows a high degree of precision in this technique.





An **indicator** is also added to the titration flask, which will change colour when the neutralisation has taken place. In this technique you should always swirl the titration flask as you are running solution from the burette into it, this ensures thorough mixing of the chemicals. A white tile should also be placed under the titration flask to allow the colour change to be clearly seen.

In a titration experiment results must be **concordant**. This means that volume readings from the burette should be within 0·2 cm^3 of each other.

Results should be recorded in a table like the following.

	Rough	Run 1	Run 2
Start Volume (cm^3)	0	16·2	32·3
End Volume (cm^3)	16·2	32·3	48·5
Titre (cm^3)	16·2	16·1	16·2

$$Average\ Titre = \frac{Run\ 1 + Run\ 2}{2}$$

Never use the rough titre value in any calculation, only use concordant titres.