WJEC Wales Chemistry GCSE

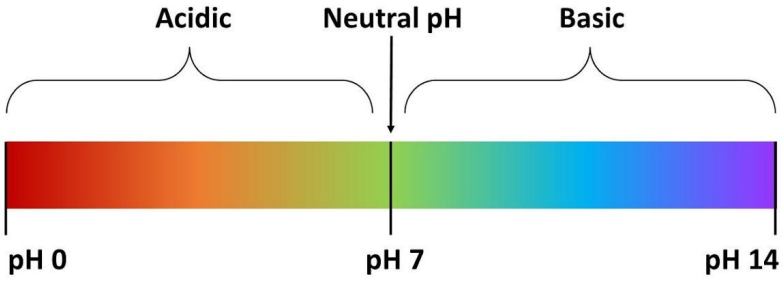
2.2: Acids, bases and salts

Detailed notes

The pH scale

The pH scale (0 to 14) measures the acidity or alkalinity of a solution and can be measured using universal indicator or a pH probe:

- pH 7 is neutral
- Less than pH 7 is acidic
    - The lower the pH, the stronger the acid.
- More than pH 7 is alkaline / basic
    - The higher the pH, the stronger the alkali.
- As the pH decreases by one unit, the H^+ concentration of the solution increases by a factor of 10.
- An alkali is a base that dissolves in water
- The pH scale



Acids and alkalis

Acids

- Acidic solutions release hydrogen ions, H^+, in solution
- Strong acid = completely dissociates to release H^+ ions in aqueous solution
    - Hydrochloric, nitric and sulfuric acids
- Weak acid = partially dissociates to release H^+ ions in aqueous solution
    - Ethanoic, citric and carbonic acids

Alkalis

- Alkali solutions contains hydroxide ions, OH^-
- Strong bases fully dissociate to release OH^- ions in aqueous solution
    - Sodium hydroxide, potassium hydroxide
- Weak bases partially dissociate to release OH^- ions in aqueous solution
    - Ammonia, ammonium hydroxide

Describing acids and bases

- Acids and bases can be referred to a strong/weak and dilute/concentrated. These sets of words should not be confused.
- Dilute / concentrated refers to the amount of substance present - to the number of moles of that acid / base in solution
- Weak / strong refers to the degree of ionisation of the acid or base - how readily the acid releases H^+ ions or how readily the base releases OH^- ions

Reactions of acids

Reaction of dilute acid with metals

Acid + metal → salt + hydrogen

- The reaction depends on the reactivity of the metal. The reactivity series shows the relative reactivities of different metals.

Neutralisation of dilute acids

Acid + alkali → salt + water

Acid + base → salt + water

Acid + metal carbonate → salt + water + carbon dioxide

- All three of these above reactions are neutralisation reactions
- Examples of alkalis are soluble metal hydroxides
- Examples of bases are insoluble metal hydroxides
- The salt produced depends on the acid used and the positive ions in the base, alkali or carbonate.

HIGHER TIER ONLY - Neutralisation

Any neutralisation involves the reaction of hydrogen ions with hydroxide ions:

H^+ (aq) + OH^- (aq) → H_2O (l)

Salts

Naming salts

The salt produced…

- Depends on the acid used…
  - Hydrochloric acid produces chlorides
  - Nitric acid produces nitrates
  - Sulfuric acid produces sulfates
- It also depends on the positive ions in the base, alkali or carbonate i.e. the metal, which makes up the first part of the name e.g. sodium chloride
- Examples:
  Sodium oxide + hydrochloric acid → sodium chloride + water
  Potassium carbonate + nitric acid → potassium nitrate + water + carbon dioxide

Preparing soluble salts

Soluble salts can be made from acids by reacting them with solid insoluble substances, such as metals, metal oxides, hydroxides or carbonates:

1. Measure a set volume of your acid
2. Heat the acid gently
3. Add the chosen base in excess (until no more will dissolve). You know the acid has been neutralised when excess solid sinks to the bottom
4. Filter the excess base using filter paper and a funnel

5. Heat the salt solution to evaporate the water (to make the solution more concentrated)
6. Leave the rest to evaporate slowly so crystals of the salt form.

Example - if you wanted to produce copper sulphate then you would need to use sulfuric acid and an insoluble copper compound, such as copper oxide.

Preparing insoluble salts

Insoluble salts can be made in a precipitation reaction.

1. React 2 solutions that contain the ions of your desired salt (for instance, to make lead sulphate you need solutions containing lead ions and sulfate ions)
2. A solid precipitate of your salt is produced
3. Filter the salt out using filter paper and a funnel
4. Wash with distilled water and leave the salt to dry on the filter paper

Titrations

The volumes of acid and alkali solutions that react with each other can be measured by titration using a suitable indicator.

How to carry out a titration:

1. Add acid to burette using a funnel, record the start volume of the burette
2. Add a known volume of alkali to a conical flask and add a few drops of indicator (such as phenolphthalein)
3. Place the conical flask on a white tile so you can see the colour change clearly
4. Turn the tap of the burette to slowly add acid to alkali until you reach the neutralisation point when the indicator changes colour.
    - If using phenolphthalein - the indicator is pink when the solution is alkali and colourless when acidic. For this reaction the neutralisation point is when the solution turns from pink to colourless.
5. Calculate the volume of acid. This is called the titre
6. Repeat until you get concordant titres - titres within 0.1 cm^3 of each other

Titration calculations

- Once you have carried out a titration and obtained concordant results use all concordant results to calculate the mean titre. Exclude results that aren't concordant when calculating the mean.
- **HIGHER TIER ONLY: If you only knew the concentration of the acid and wanted to calculate the concentration of the alkali:**
    - **Calculate moles of acid using moles = concentration x volume**
    - **Calculate the mole ratio of acid to alkali using the balanced chemical equation for the reaction**
    - **Work out how many moles of alkali you have using the mole ratio and moles of acid (e.g. if you have 5 moles of acid and the ratio of acid to alkali is 1:2, you will have 10 moles of alkali)**
    - **Calculate the concentration of the alkali using concentration = mol ÷ volume**

- **The units of concentration when calculated this way are given in mol dm^{-3}**

Chemical tests

Test for carbon dioxide gas

- Bubble the gas through the limewater (calcium hydroxide solution) and it will turn milky (cloudy) if carbon dioxide is present.

Test for carbonates

- Carbonates react with dilute acids to create carbon dioxide.
- This gas can be bubbled through limewater; if the limewater goes cloudy, the gas is CO_2.

Test for sulfate ions

- First add dilute hydrochloric acid, followed by barium chloride solution.
- A white precipitate will form if sulfate ions are in this solution